WIND PROSPECTING IN BRITISH COLUMBIA, CANADA:

A REPORT ON THE FEASIBILITY OF THE STANDING OFFER PROGRAM

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I, Michelle Closson, declare that this Dissertation is an account of my own research and that I have acknowledged appropriately.

ABSTRACT

This report evaluated the effectiveness of the BC Hydro Standing Offer Program (SOP) at encouraging the development of smaller wind projects. The BC Predicted Wind Speed Atlas, collected meteorological data, and RETscreen financial model were used to conduct feasibility analyses in four promising regions – Vancouver Island, North Coast, Eastern and Southern Interior, and the Peace region.

The BC Predicted Wind Speed Map was used as a tool to identify where the average annual wind speed is sufficient to warrant a feasible project under the BC Hydro Standing Offer Program according to a variety of assumptions and constraints. Collected meteorological data was used to validate the BC Wind Atlas. The report concludes that the BC Predicted Wind Speed Atlas is an accurate tool and can be used by developers for identifying areas of good wind potential to initiate assessment.

RETScreen was used to conduct the financial analysis. Four analyses were conducted for each of the regions to determine the wind speed required for projects signing a 20 or 40 year SOP contract in order to achieve 0% or 8% internal rate of return (IRR). The IRR was used as a measure to determine the financial viability of a project. An 8% IRR is considered relatively low from the perspective of financers, but was considered in this report as the lower range suitable for smaller, community-based projects. Realistically, the IRR would typically be required to be at least 12% in order to be considered for project financing.

The financial analysis revealed that the BC Hydro Standing Offer Program does not provide an adequate payment price to encourage development of small wind projects.

The report highly recommends that BC Hydro increase the base payment prices to at least 11 cents per kilowatt hour at the two year review period.

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Chapter 1.0 - Introduction

1.1 Background

The current installed capacity of wind power in Canada is almost 1900 MW (CANWEA, 2008). Despite the size of British Columbia (~ 944,000 km^2; more than twice the size of California) and its lengthy coastline (~ 25,000 km), the province has yet to connect any wind farms to the grid. The majority of British Columbia's power is derived from hydro electric generation systems (~80%) while the remaining comes from thermal power stations. It is expected that energy demand in British Columbia (BC) will increase by approximately 33% by the year 2023 (Deveau, 2004). Although the World Energy Council, FortisBank, and Petroleum Economist have declared that BC has some of the best conditions for viable wind energy projects in North America, it is still only just beginning construction to tap into this untouched resource (BCWEA, 2005). The *BC Energy Plan: A Vision for Clean Energy Leadership* aspires for power generation from renewable sources to continue to account for at least 90% of the total generation in the province (MEMP, 2007).

It was not until recently that developers began to seriously evaluate the wind resource and the feasibility of wind power in BC. The quality and resolution of publicly available wind data for the province is relatively low compared to other Canadian provinces. In the recent past, most of the publicly available wind data in BC came from airport weather stations - a poor representation of wind potential. Area-specific wind resource modeling can be completed for developers by consulting companies, but this can be an expensive exercise. Consequently, in the year 2000, BC Hydro hired consultants to

produce the BC Predicted Wind Speed Map for public access. The map was developed using a Meso-Map System which couples weather modeling with topographical and land cover data. Additionally, BC Hydro installed meteorological towers at 18 sites throughout the province between 2000 and 2003. These towers were erected in four regions of the Province that had been identified as having the most promising wind resources, namely Vancouver Island, Peace Region, Southern and Easter Interior, and the North Coast. This wind data is available to the public for free download. BC Hydro made the wind resource data available to the public in order to encourage developers to assess potential wind sites by reducing barriers to data acquisition.

There are several characteristics that dictate the feasibility of a wind power facility;

1. Wind resource availability,
2. Proximity to the grid,
3. Site access, and
4. Power purchase agreement.

In other words, where is the good wind, how far is it from the grid, is the terrain navigable, and will anyone pay a reasonable price for what is generated, are very important questions that will weigh on the minds of developers in an unexploited and largely unexplored territory.

According to the Canadian Wind Energy Association (CANWEA), as of June 2008, there were three wind projects with signed purchase agreements and/or already under construction in BC. The Dokie Wind Project is a 144 MW wind park under construction in the Peace Region of northeastern BC and is expected to be first one built in the province; Bear Mountain Wind Park, another Peace Region project, will be 100 MW; and Mount Hays Wind Farm is a 25.5 MW wind project that will be located in the North Coast region. All three projects were awarded power purchase agreements by BC Hydro.

While it is evident that large-scale developments have been able to make some headway, if one were prudent, investing time and money to enter a competitive Call for Power process might be considered too risky. BC Hydro has issued several "calls for power" with various requirements for participants and projects. The 2006 Call for Power awarded power purchase agreements to the wind projects noted above, however it is a process that is administratively discouraging for participation by small developers. In response, the BC Energy Plan mandated the Standing Offer Program (SOP) which was launched in April, 2008. The SOP provides a simplified, non-competitive, and less expensive process of granting contracts to projects with a capacity that does not exceed 10 MW. By decreasing the costs of participation for developers, the SOP allows smaller clean energy projects to be constructed more easily. This type of program reflects a government that sees the value of cleaner power production, regardless of scale. By creating an incentive whereby reducing greenhouse gas emissions is not a dream that can only be realized by big business or those backed by extraordinary investment, the SOP

motivates a grass-roots movement for passionate people and groups that want to improve air quality in a capacity they can afford.

The power payment price for SOP projects varies depending on location, time of year, and time of day. While this program is encouraging in theory, there are already concerns that the purchase price is too low to promote economically feasible small wind farm development in many areas of the province. This report seeks to determine the feasibility of projects under the SOP and identify where prospective wind projects exist. To do this, the following objectives are addressed:

- To determine if the BC Predicted Wind Speed Map is an accurate tool that can confidently be used for prospecting by comparing mapped ranges to collected wind speed averages.
- To identify where and under what economic circumstances Standing Offer-sized wind projects are feasible in British Columbia using RETScreen economic software.
- To determine if the SOP is a useful incentive that will encourage development of small (50 kW to 10 MW) wind projects.

1.2 Report Outline

The purpose of this report is to investigate the feasibility of wind development in British Columbia under BC Hydro's Standing Offer Program (SOP). In order to determine whether this government incentive encourages development of wind power, desktop research, as well as the BC Hydro data and wind atlas, Manifold GIS software and RETScreen economic analysis software program have been utilized.

Chapter 2 is an overview of the context of wind power in British Columbia; wind resource potential with a regional focus, interconnection, policy, and collected and predicted wind data are briefly discussed. In Chapter 3, the MesoMap system used to create the BC Predicted Wind Speed Map is introduced, explained, and its assumptions and limitations discussed. Chapter 4 introduces wind resource data collected from towers around BC, discusses where and how data was collected, and how the data was analyzed, including discussion on assumptions and limitations. In Chapter 5, the predictive map is validated through comparison with the collected wind data. In Chapter 6, the regional economic feasibility of Standing Offer-sized wind projects is assessed using RETScreen. In Chapter 7, a prospecting exercise is conducted, describing the scope and identifies potential sites for feasible wind development. Sources of error are discussed in Chapter 8. Chapter 9 includes a discussion and further work possibilities. Finally Chapter 10 includes a conclusions and recommendations for developers and BC Hydro.

Chapter 2.0 – Wind Power Potential – A British Columbia Context

2.1 Introduction

Global wind patterns and local wind systems contribute to variations in wind speed and wind direction. Global or geostrophic winds are driven by differences in temperature and pressure. These winds determine the prevailing wind direction. Local wind systems are influenced by temperature gradients and topographic effects of the earth's surface, including roughness of terrain and terrain contours, and often determine the most common wind direction.

British Columbia has vast expanses of coast and mountainous terrain that promote sea breezes and mountain induced winds. These local wind patterns can have extremely powerful and predictable wind regimes and hence provide obvious potential wind farm sites. In addition to strong wind energy potential, proximity to the electrical grid, the accessibility of a site, load demand, and encouraging policies are significant variables when determining the feasibility of a project site.

This chapter briefly discusses the current state of development of wind projects in the province, the wind regime in the most promising regions for development, interconnection, and provincial and federal policies. It provides a useful context as well as background information that are important to the financial analysis in Chapter 7.

2.2 State of Development of Wind Farms in British Columbia

The Dokie Wind Project (144 MW) and Bear Mountain Wind Park (100 MW) are to be located in the Peace Region and the Mount Hays Wind Farm (25.5 MW) is to be located in the North Coast Region. All three projects were awarded power purchase agreements by the BC Hydro 2006 Clean Power Call.

Fifteen other projects are in the later stages of development either having completed or almost completed the Environmental Assessment Process, and will be submitting proposals to the 2008 Clean Power Call. Some of the more high profile projects include the 700 MW Banks Island Wind Farm off the North Coast of BC, the 320 MW off-shore Nai Kun Wind Farm off the east coast of the Queen Charlottes/Haida Gwaii islands (first of five phases), and the 99 MW Know Hill Wind Farm on Northern Vancouver Island (BC Government, 2008). In addition to the projects mentioned above, there are hundreds of other sites in BC under investigation.

Very few projects are being planned on private land. The majority of projects are proposed on Crown Land, which makes up ninety-five percent of the province, and covers areas with high wind energy potential such as mountain ridges (BC Min. of Agriculture and Lands, 2008a). Accordingly, policy for tenure of Crown land for wind energy projects has been developed by the BC Ministry of Energy, Mines and Petroleum Resources (BC Min. of Agriculture and Lands, 2008b). As of September 2008, there were over 400 posted applications for Investigative Use Permits for wind power projects

in the province. The majority of projects under investigation are concentrated in the Peace Region, North Coast, Eastern and Central Interior, and on Northern Vancouver Island.

2.3 Wind Regime – A Regional Focus

This report focuses on the following four regions of BC that have been identified as having the strongest wind development potential and where wind development is most active: Vancouver Island, the North Cost, the Peace region, and the Southern and Eastern Interior. Nevertheless, the feasibility of wind projects in all regions could be significantly affected by issues such as proximity to the grid, site access prevented by terrain features such as ridges, turbine suitability for local conditions, and regional power demand (GH, 2008). The four regions of focus are illustrated in **Figure 2.1** and described in greater detail in the following sections.

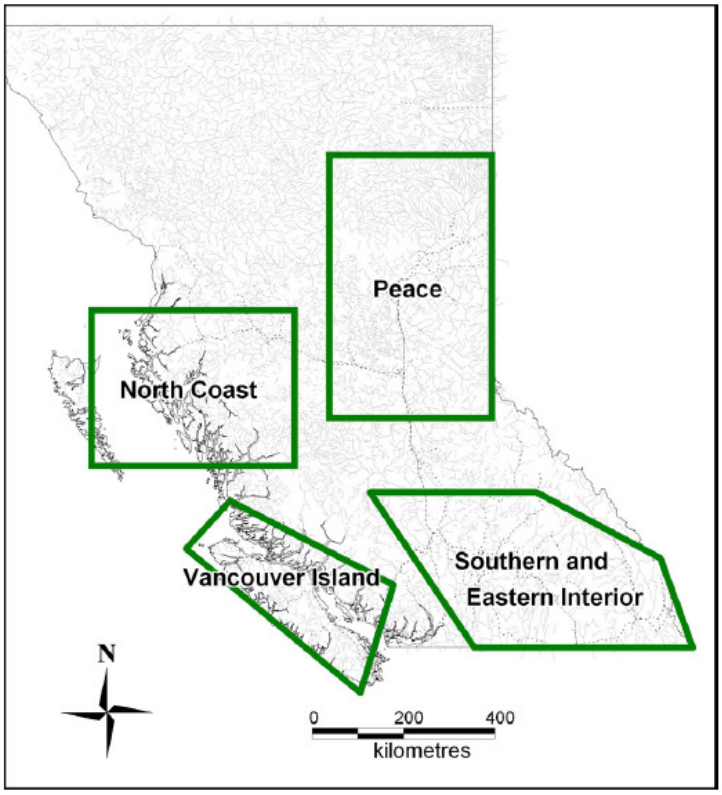

Figure 2.1: Areas with greatest wind development potential in BC

[BC Hydro LTAP Resource Options Update www.bchydro.com/rx_files/info/info54510.pdf]

2.3.1 Vancouver Island

Vancouver Island is located off the southwest coast of British Columbia. The majority of wind farm sites proposed in BC are located on the Island to take advantage of exposure to the coast and terrain features (GH, 2008). The predominant wind regime is driven from the southeast and northwest. High mean annual wind speeds (6.5 – 8.0 ms^{-1} at 80 m hub height) are expected for areas where conditions are suitable and that are well exposed.

2.3.2 North Coast Region

The North Coast Region covers the western central coast of BC. Promising wind sites are located inland near Smithers, Prince Rupert, and Kitimat, as well as on coastal islands on the east side of Hecate Strait. The predominant wind regime is driven from the southeast direction, parallel to the coast. Significant westerly winds have also been suggested (GH, 2008). High mean annual wind speeds (6.5 – 8.5 ms^{-1} at 80 m hub height) are expected in this region, being particularly high in sheltered inland and coastal island sites.

2.3.3 Peace Region

The Peace region covers a large expanse of eastern mainland BC. The complex mountainous terrain makes predictions of local wind conditions difficult and therefore highly localized. The promising wind sites would exploit elevated, exposed areas with the speedup effects from terrain. The predominant wind regime comes from the west and southeast depending on the site location. Relatively high mean annual average wind speeds (7.5 - 10.5 m s^{-1}at 80 m hub height) are expected in this region.

2.3.4 Southern and Eastern Interior Regions

This region covers the largest area extending through southern and eastern interior parts of BC. As with the Peace region, the promising wind sites would exploit elevated, exposed areas with the speedup effects from terrain, as well as lengthy plateaus. Depending on the location, the wind regime is predominantly from the southwest or from the northeast and southwest directions. High mean annual wind speeds (6.0 – 8.0 m s^{-1} at 80 m hub height) are expected in this region, in suitably well exposed sites. The

complex mountainous terrain makes predictions of local wind conditions difficult and therefore highly localized.

2.4 Interconnection

BC Hydro and the British Columbia Transmission Corporation (BCTC) are the two groups responsible for most of the BC electricity grid. BC Hydro is responsible for managing the distribution grid while the transmission lines throughout the province are managed by BCTC. BC Hydro and the BCTC are governed by the BC Utilities Commission. Distribution line voltages in BC are commonly 12 kV and 25 kV. The transmission line voltages are commonly 69 kV, 138 kV, 230 kV, and 500 kV. Most wind projects will likely connect to the transmission lines, however some Standing Offer-sized projects (50 kW to 10 MW) can connect to the 25 kV distribution lines. **Figure 2.2** shows the BC Electricity and Distribution Grid. In this report, the economic feasibility and site prospecting analyses in Chapters 6 and 7 assume a conservative but realistic distance of 5 km from 69 kV transmission lines.

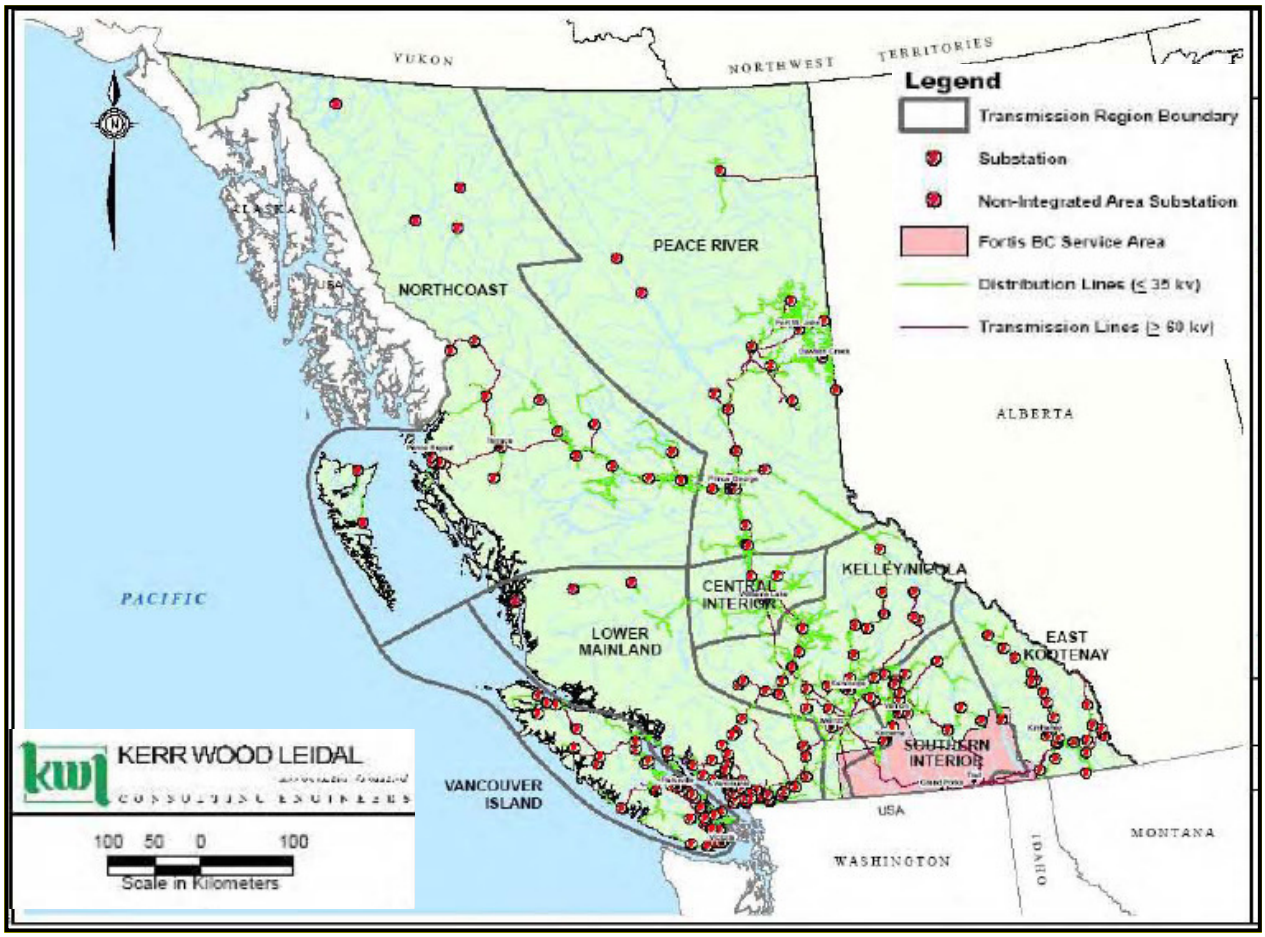

Figure 2.2. BC Hydro Transmission and Distribution Grid (BC Hydro, 2008c).

In April 2008, the BCTC released a Stage 1 Study Report on the Wind Integration Project – Transmission Planning Study that examined the impact on the transmission network of connecting intermittent generation systems, such as individual wind power facilities, in different regions around BC (BCTC, 2008). The report also proposed solutions, such as reinforcing existing lines and adding new transformers, to integrate wind power into the grid in a reliable and cost-effective manner. Transient voltage dip and branch overload were determined to be the most restrictive factors of the existing system. It was concluded that the BC transmission system has the ability to integrate

substantial wind generation in different areas studied in the Peace region, North Coast, Northern Vancouver Island, and the Eastern interior.

2.5 Provincial and Federal Policies for Wind Power

The response to the BC Hydro Calls for Power demonstrates the interest in developing wind power in the province and the anticipation for a positive return on investment on large-scale wind energy development. But the question remains whether projects on a smaller scale have the ability to be prosperous. The purpose of this report is to evaluate the effectiveness of the BC Hydro Standing Offer Program at encouraging the development of smaller (<10 MW) projects and illustrate where potential projects might be located.

This section introduces the rules of the existing provincial incentive, as well as the federal ecoENERGY Renewable Power Program that has been included in the financial analysis in Chapter 6.

2.5.1 BC Hydro Calls for Power

BC Hydro has been issuing Calls for Power from Independent Power Producers for green power projects since 2002. The calls have had various requirements for projects and participants. This is a competitive process whereby BC Hydro reviews the project proposals and selects those that are the most economically viable. The first wind energy project in BC, Holberg, was awarded a Power Purchase Agreement in the 2005 Call for

Power. However this project was cancelled, partly due to the proponent deciding that the agreed upon power purchase price was too low to afford development. The Call for Tenders process was changed to a request for proposals (RFP) -style Clean Power Call in order to provide more flexibility to BC Hydro when working with developers in drafting contract terms that are cost-effective and conditions catering to the needs of large, complex power projects (BC Hydro, 2008b).

The most recent 2008 Clean Power Call was issued in June, 2008. The RFP target will be to acquire 5,000 GWh per year for seasonal and hourly peak energy demands.

2.5.2 BC Hydro Standing Offer Program (SOP)

The Standing Offer Program (SOP) is a new initiative of BC Hydro that launched in April 2008 to facilitate development of wind energy by purchasing the energy from small projects with a nameplate capacity between 50 kW and 10 MW. The SOP was developed to provide a more straightforward, non-competitive and cheaper process, granting contracts for projects meeting specific criteria (BC Hydro, 2008).

Under the SOP, BC Hydro offers a variable base payment price for all Proven Generation Technologies, which can range from $69-$84 per megawatt hour according to region and time of delivery. Higher payment prices are offered in regions such as Vancouver Island where the project can be located near a load centre. The base price will not be revised any earlier than the second year of the program. Monthly and diurnal multipliers are also applied to the base price according to periods of heavy and light

load. Heavy load hours are considered to be between 06:00 to 22:00 Pacific Time, Monday through Saturday (excluding statutory holidays). Light load hours are all those that are not heavy load hours. In addition, a payment of $3.10 per megawatt hour is available for the Environmental Attributes (BC Hydro, 2008). **Table 2.1** and T**able 2.2** outline the price structure from the SOP terms for the regional base price and time of delivery multipliers respectively. Developers can sign into contracts for 20 or 40 year terms.

Table 2.1 Regional base price, Environmental Attributes Price, and Total Price.

Region	Base Price (2008$/MWh)	Environmental Attributes Price (if any) (CAN$/MWh)	Total Price (CAN$/MWh)
Vancouver Island	84.23	3.10	87.33
Lower Mainland	83.86	3.10	86.96
Kelly/Nicola	80.31	3.10	83.41
Central Interior	77.53	3.10	80.63
Peace Region	69.94	3.10	73.04
North Coast	71.37	3.10	74.47
South Interior	72.27	3.10	75.37
East Kootenay	76.05	3.10	79.15

Table 2.2 Base price escalation.

Time of Delivery	Adjustment to Escalated Base Price (percentage)	
Month	**Heavy Load Hours (HLH)**	**Light Load Hours (LLH)**
January	125%	106%
February	126%	110%
March	114%	106%
April	103%	95%
May	92%	76%
June	90%	72%
July	91%	72%
August	95%	81%
September	96%	88%
October	108%	97%
November	109%	102%
December	122%	102%

This report assesses whether the payment price is sufficient to attract development of smaller wind projects in different regions throughout the province.

2.5.3 ecoENERGY for Renewable Power

The ecoENERGY for Renewable Power program (EERP) is a federal initiative that started in April, 2007. Its mandate is to increase the supply of renewable power sources. For up to 10 years, the program will provide a one cent per kilowatt-hour financial incentive for projects constructed before March 31, 2011. Unlike other provinces, such as Ontario, a developer in BC is not required to transfer any of the incentive claimed under the ecoENERGY program to the utility, BC Hydro.

Chapter 3.0 –

British Columbia Predicted Wind Speed Map - MesoMap System

3.1 Introduction

In 2000, BC Hydro conducted a wind mapping initiative with the purpose of identifying potential wind sites. Consulting company, AWS Truewind, was commissioned to develop the British Columbia Predicted Wind Speed Map. The map (*see* ***Appendix A***) image displays colour-coded predictions of the average annual wind speed in metres per second at 65 m hub height at a 1000 m resolution (BC Hydro, 2000).The wind speeds are rated poor (<4 m/s), fair (4 -6 m/s), good (6-8 m/s), or very good (> 8 m/s). The map was intended to be used as a macroscale prospecting tool for developers to identify potential sites for wind power projects. It was also useful for BC Hydro to determine the potential future energy that could be generated by wind. Currently, additional wind potential and characteristics are being modeled in a new mesoscale wind data study commissioned by BC Hydro.

The BC Predicted Wind Speed Map was created using the MesoMap system. This system is a dynamic atmospheric simulation model which combines mesoscale and microscale mathematical models, weather databases, and computer systems to predict wind speeds at a high resolution over large regions without surface wind measurements. It is capable of managing complex wind conditions, such as lake-sea breezes and katabatic mountain winds. MesoMap is considered one of the strongest and most

accurate systems available for wind mapping compared to similar models (AWS Truewind, ?).

The BC Predicted Wind Speed Map is used in this report as a tool to identify where the average annual wind speed is sufficient to warrant a feasible project under the BC Hydro Standing Offer Program according to a variety of assumptions and constraints (see Chapter 7 – *Prospecting for SOP*). The map is validated in Chapter 5 – Map Validation. The sections to follow describe the models used, data sources, mapping process, and assumptions and limitations of the MesoMap system used to develop the BC Predicted Wind Speed Map.

3.2 MesoMap Models

The MesoMap system combines two models. A mesoscale weather model (MASS) is used to initialize the microscale wind flow model (WindMap) (AWST, ?b). MASS or Mesoscale Atmospheric Simulation System is a numerical weather model developed by MESO Inc. It is different from other mesoscale models as it has been specifically adapted for wind resource assessment. The important meteorological inputs into MASS are reanalysis and rawinsonde data (*see section 3.3*). Using this data, MASS determines the evolution of wind and weather patterns that reflect factors such as terrain, oceans and lakes, vegetation, and solar heating. MASS is a dynamic model that simulates atmospheric conditions in short time steps. Processing of the model is computationally demanding, therefore MASS is coupled with WindMap, a less complex and faster model.

WindMap is a mass-conserving wind flow model that is used to account for local terrain and surface roughness variations, improving the resolution of the MASS simulations.

In the case of the BC Predicted Wind Speed Map, the results of the model were assembled to produce a map of mean wind speed.

3.3 Data Sources

The MASS model utilizes a combination of global, meteorological and geophysical databases. The key meteorological inputs into MASS are rawinsonde and reanalysis data, and measurements of land surface (BC Hydro, 2004).The reanalysis database is produced by the US National Centres for Environmental Prediction and the National Centre for Atmospheric Research. It is composed of gridded historical atmospheric conditions at all levels of the atmosphere in intervals of six hours and is considered to be the most important database to MASS. The important land cover inputs are elevation, normalized differential vegetation index (NDVI), sea-surface temperature, and soil moisture. The land cover and NDVI data are translated by the model into physical parameters, such as surface roughness and albedo. The MesoMap system requires high-resolution land cover and topographical data in order to output high resolution wind maps.

3.4 The Mapping Process

The development of a wind resource map is completed by the MesoMap system following a sequence of steps. The MASS model randomly selects 366 days from a 15-year period to simulate conditions. Three-dimensional wind and other weather characteristics are generated by each simulation and are stored at hourly intervals. Then the results of the simulations are summarised in data files to be input into WindMap. For the BC Predicted Wind Speed Map, the WindMap program produced a color-coded map of wind speed at 65 metres height above ground.

3.5 Conclusion

As with any modelling system, expecting 100% accuracy is unrealistic (*see Chapter 8 – Sources of Error* for more detail*)*. However, the proven accuracy of the MesoMap system in studies across the globe instils significant confidence. Therefore, the BC Predicted Wind Speed Map generated by the MesoMap system could be considered a dependable tool for prospecting potential regions for wind sites. To validate this further, collected data was used to calculate annual average wind speeds at sites within the four focus regions (*see Chapter 4 –Collected Meteorological Data*) and then compared to the modeled wind speed range at the same location (*see Chapter 5 – Map Validation*).

Chapter 4.0 – Collected Meteorological Data

4.1 Introduction

BC Hydro performed a wind monitoring data collection program between May 2000 and August 2004 at 18 stations spread between the Peace, North Coast, Vancouver Island, and Southern and Eastern Interior regions in a variety of terrains and elevations (BC Hydro, 2004). The purpose of this initiative was to characterize the wind potential throughout the province. This data has been made available for free download on the BC Hydro website. Each regional folder includes raw, unprocessed data files. Each individual site folder includes a summary document containing information about the site, data format, and monitoring equipment. The wind monitoring stations collected a variety of meteorological data for at least one year, but have since been either taken over by other parties or decommissioned.

For this report, the collected wind speed data was formatted from its raw form, validated, and verified in order to calculate the annual average wind speeds at the monitoring locations. The average wind speeds were then adjusted to 65 metres using wind shear calculations to match the modeled hub height in the BC Predicted Wind Speed Map. Chapter 5 uses these values to compare to the map.

Not all monitoring stations were included in the final analysis. Several sites were excluded from the study, including Mount Hays, Mount Wartenbe, Puleteny Point, and Rumble North. Mount Hays was removed due to higher wind speeds at lower heights indicating suspect data or monitoring equipment. The remaining three sites were

removed due to incomplete annual data sets (*see Sections 4.4.3 – Data Quality and 4.5.1 – Wind Shear*).

4.2 Location and Duration of Monitoring

Wind monitoring data was collected at 18 stations focusing on the Peace, North Coast, Vancouver Island, and Southern and Eastern Interior regions. **Table 4.1** presents the name, region, coordinates, elevation, and approximate duration of the monitoring at the different meteorological stations. A map of the monitoring station locations is provided in **Figure 4.1**.

Table 4.1 BC Hydro meteorological station location and monitoring duration details.

Site Name	Region	Latitude		Longitude		Elev (m)	Approx. Period of Monitoring (MM/YY)
Aasen	Peace Region	55°	58.587'	120°	21.794'	757	10/01 – 07/03
Alert Bay	Vancouver Island	50°	35.717'	126°	57.133'	50	04/00 – 05/02
Ashcroft	Interior	50°	36.468'	121°	18.398'	333	12/01 – 04/03
Bald Mountain	Interior	51°	26.113'	124°	0.989'	1347	11/00 – 05/02
Bear Mountain	Peace Region	55°	43.786'	120°	26.585'	1000	10/01 – 07/04
Bessborough	Peace Region	55°	48.575'	120°	30.599'	867	10/01 – 07/03
Chilko Lake	Interior	51°	25.509'	124°	08.179'	1187	11/00 – 05/02
Erbe	Peace Region	55°	47.833'	121°	04.489'	801	10/01 – 07/03
Franklin Range	Vancouver Island	50°	29.025'	126°	40.924'	1229	09/02 – 09/03
Great Central Lake	Vancouver Island	49°	18.919'	125°	05.911'	880	09/01 – 06/03
Jordan River	Vancouver Island	48°	28.795'	124°	03.742'	671	09/00 – 05/02
Merritt	Interior	50°	07.499'	120°	38.285'	1348	12/01 – 08/03
Mount Hays	North Coast	54°	17.017'	130°	19.150'	658	10/00 – 06/04
Mount Wartenbe	Peace Region	55°	38.330'	121°	22.500'	1100	09/02 – 10/03
Port Alice	Vancouver Island	50°	25.755'	127°	27.492'	802	06/01 – 05/03
Pulteney Point	Vancouver Island	50°	37.675'	127°	09.133'	15	07/00 – 01/03
Rumble	Vancouver Island	50°	29.693'	127°	31.443'	832	09/01 – 03/04
Rumble North	Vancouver Island	50°	30.358'	127°	32.654'	695	07/02 – 08/04

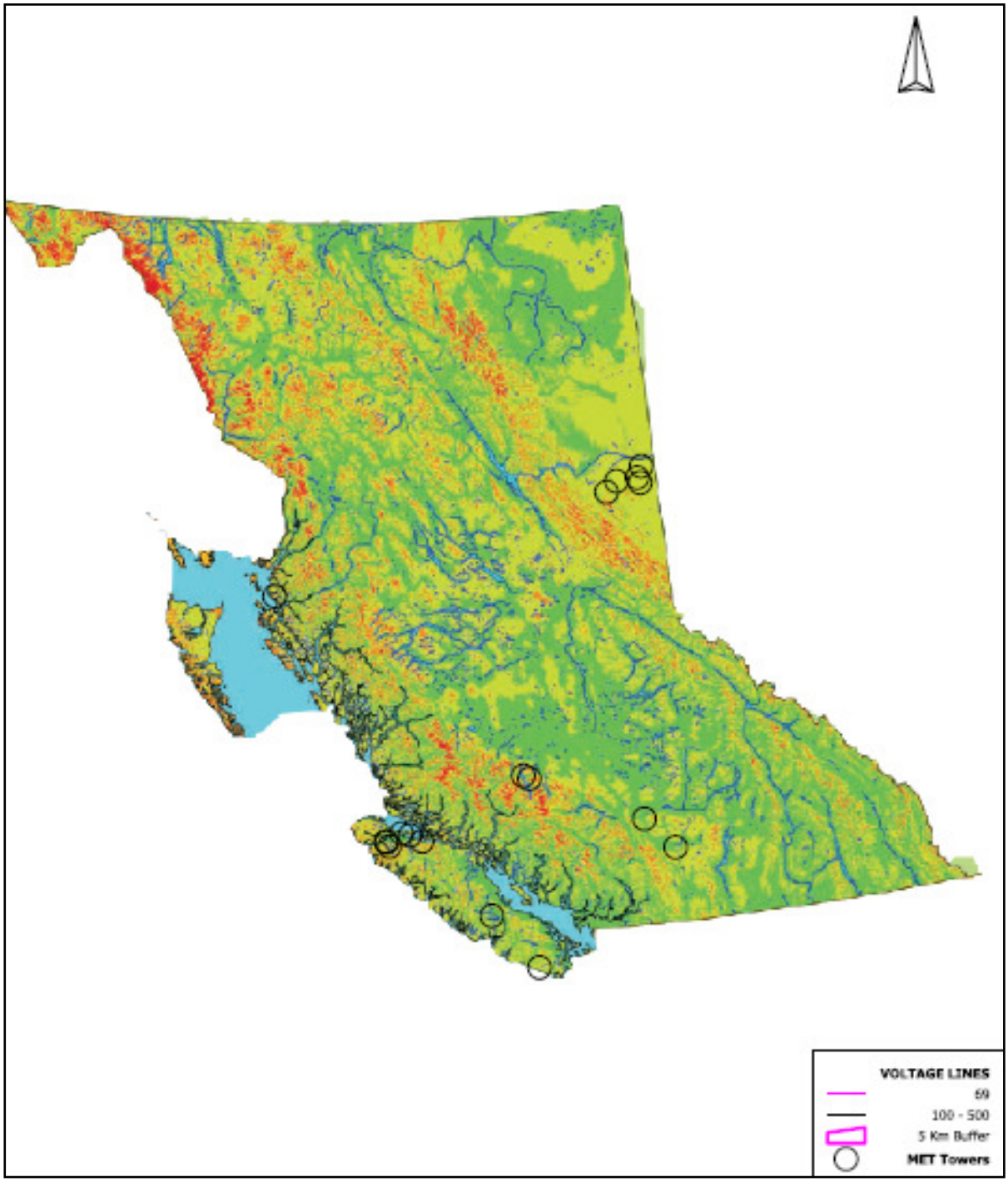

Figure 4.1 Monitoring Station Locations.

4.3 Measurement Systems

The BC Hydro wind monitoring program stations consisted of towers with wind and other sensors connected to dataloggers including a power supply and communication system. The tower type and equipment used at the different stations is included in **Appendix B**.

In general, towers were installed with wind and temperature sensors at 30 metres and/or 50 metres elevation above ground level. The arrangement of the output from the dataloggers was of particular importance to the formatting of the data for this report. Campbell Scientific and NRG Systems dataloggers were the two types used in the monitoring program. A brief description of the output from the dataloggers is provided below.

4.3.1 Campbell Scientific

Campbell Scientific dataloggers record sensor readings at one second intervals which are averaged into 10-minute measurements. Collected data records are presented in rows of 10-minute records and a daily record row at the end of each day.

4.3.2 NRG Dataloggers

NRG dataloggers record sensor readings that are collected at two second intervals and averaged into 10-minute measurements as well as standard deviation, minimum and maximum values for each sensor. Dates are recorded as year-month-day.

4.4 Data

4.4.1 Data Overview

The type of meteorological and system data collected and recorded at each station are included in **Table 4.2**.

Table 4.2 Data collected from sensors and system.

Variable	Unit
Wind Speed (avg., max, min, vertical, standard deviation)	m/s
Wind direction	0-360 degrees
Ambient Air Temperature (avg, min, max)	degrees C
Barometric Pressure	kPa
Julian day	n/a
Relative Humidity	%
Voltage (avg, min, max)	Volts

The data is provided with the following disclaimer:

> *"BC Hydro does not represent, guarantee or warrant to any third party, either expressly or by implication: (a) the accuracy, completeness or usefulness of, (b) the intellectual or other property rights of any person or party in, or (c) the merchantability, safety or fitness for purpose of, any information, product or process disclosed, or described in this wind data."*
>
> *(BC Hydro, 2004)*

4.4.2 Data Format

The meteorological station data is provided in a raw, unprocessed format. Each general region for wind monitoring – Peace, North Coast, Vancouver Island, and Eastern and Southern Interior – has a compressed (.zip) file. Each file is in comma-delimited format. For the purposes of this report, data files were imported into excel to verify and manipulate data, and perform calculations with ease.

4.5 Data Manipulation

4.5.1 Data Arrangement

After the raw data were imported and verified, the data that had been collected from monitoring stations utilizing the Campbell Scientific (CS) dataloggers required further filtering. The CS dataloggers include 10-minute and daily records. For the purposes of the analysis in this study, the daily records were removed from each dataset so that monthly average wind speeds could be calculated. Next the average annual wind speeds were calculated for all monitoring stations at each wind sensor height.

4.5.2 Wind Shear

Wind speed data was collected using elevated wind sensors. Ten of the fourteen monitoring stations collected wind speed data at 30 metres and 50 metres; two monitoring stations collected wind speed data at 20 metres and 30 metres; two other monitoring stations collected wind speed data at only 30 metres.

Wind shear calculations were used to adjust the candidate data to a 65 metre hub height in order to compare values to ranges illustrated in the BC Predicted Wind Speed Map. The mean annual wind speeds derived for Merritt, Ashcroft, Bear Mountain, Bessborough, Aasen, Erbe, Alert Bay, Jordan River, Rumble, Port Alice, Great Central Lake, and Franklin Range were extrapolated to a 65 metre hub height by calculating their wind shear exponent after rearranging the formula for wind shear (see below). The wind shear exponents were estimated for sites with sensors at only one height; the wind shear exponents at Bald Mountain and Chilko Lake were estimated to 0.25 based on the appearance of scattered forested terrain on Google Earth. Final velocities were calculated using the following expression for wind shear:

$$v / v_o = (h / h_o)^{\alpha}$$

where,

v = the velocity at height h (m/s)

v_o = the velocity at height h_o (m/s)

α = the wind shear exponent

4.6 Results

The annual average wind speeds at the 14 BC Hydro Monitoring Stations included in this analysis, extrapolated to a 65 metre hub height, are presented in **Table 4.3**.

Table 4.3 Annual average wind speeds at 65 metres.

Site Name	Region	Measured Wind Speed @ 65 m (m/s)
Bald Mountain	Interior	6.28
Chilko Lake	Interior	4.46
Merritt	Interior	5.8
Ashcroft	Interior	4.07
Mount Hays	North Coast	Removed from analysis – wind shear problems
Bear Mountain	Peace Region	7.49
Bessborough	Peace Region	5.7
Aasen	Peace Region	5.67
Erbe	Peace Region	5.32
Mount Wartenbe	Peace Region	Removed from analysis – incomplete data set
Alert Bay	Vancouver Island	5.8
Jordan River	Vancouver Island	5.23
Pulteney Point	Vancouver Island	Removed from analysis– incomplete data set
Port Alice	Vancouver Island	4.77
Great Central Lake	Vancouver Island	3.27
Rumble	Vancouver Island	6.68
Rumble North	Vancouver Island	Removed from analysis– incomplete data set
Franklin Range	Vancouver Island	4.7

4.7 Conclusions

BC Hydro included summary files for each monitoring station that provided information about known gaps in the data, including explanations if known. Due to the number of known gaps in data collected at Mount Wartenbe and Rumble North, the

data sets were deemed incomplete for annual averaging and excluded from this analysis. Data validation and verification was performed for each remaining datasets. A range test was performed on all wind speed data to highlight values outside the 0 to 25 m/s range. Suspect values were examined and either retained or rejected depending on their context in the data set. Data sets from all monitoring stations produced data recovery rates between 97% and 100%. The accuracy of the monitoring equipment used in the data collection program was assumed to adhere to the standards specified by the manufacturer. *See Section 8.3 – Monitoring Equipment* for more details on the assumed accuracy of monitoring equipment.

In general, some uncertainty exists in these datasets, however based on the station summary files provided by BC Hydro, assumed accuracy of monitoring equipment, the data recovery rates, and the industry standard wind shear calculation utilized, the results are considered accurate enough for the purposes of this report (*see Chapter 8 – Sources of Error* for more detail). Based on the reasonable accuracy of the modeled map and the collected data, the following chapter attempts to validate the BC Predicted Wind Speed Map by comparing wind speeds at monitoring station locations.

Chapter 5.0 – Map Comparison

5.1 Introduction

The previous chapters have briefly addressed the accuracy of the modeled BC Predicted Wind Speed Map and observed data. This chapter attempts to further validate the modeled map by comparing the average annual wind speeds from the collected data to the location on the modeled map. Although the model has been proven effective for mapping large areas, the question remains on whether it is suitable for selecting promising project sites. The purpose of this exercise is to be able to determine if the map is a reliable tool for identifying prospective wind sites.

5.2 Comparison of Model Map to Collected Data

For this report, a map was prepared to show the wind resource in the province as predicted by the model overlaid with the monitoring station locations. The modeled map was georeferenced in Manifold, a GIS software program, by georegistering known coordinates of the province. The BC Hydro monitoring station locations were added to the map.

For presentation in this report, the prepared map was divided into three regional sections; **Figure 5.1** displays the Peace Region, **Figure 5.2** displays Vancouver Island, and **Figure 3.2** displays the Eastern and Southern Interior region. The North Coast is not included in this comparison because the only monitoring station in that region was omitted from this study.

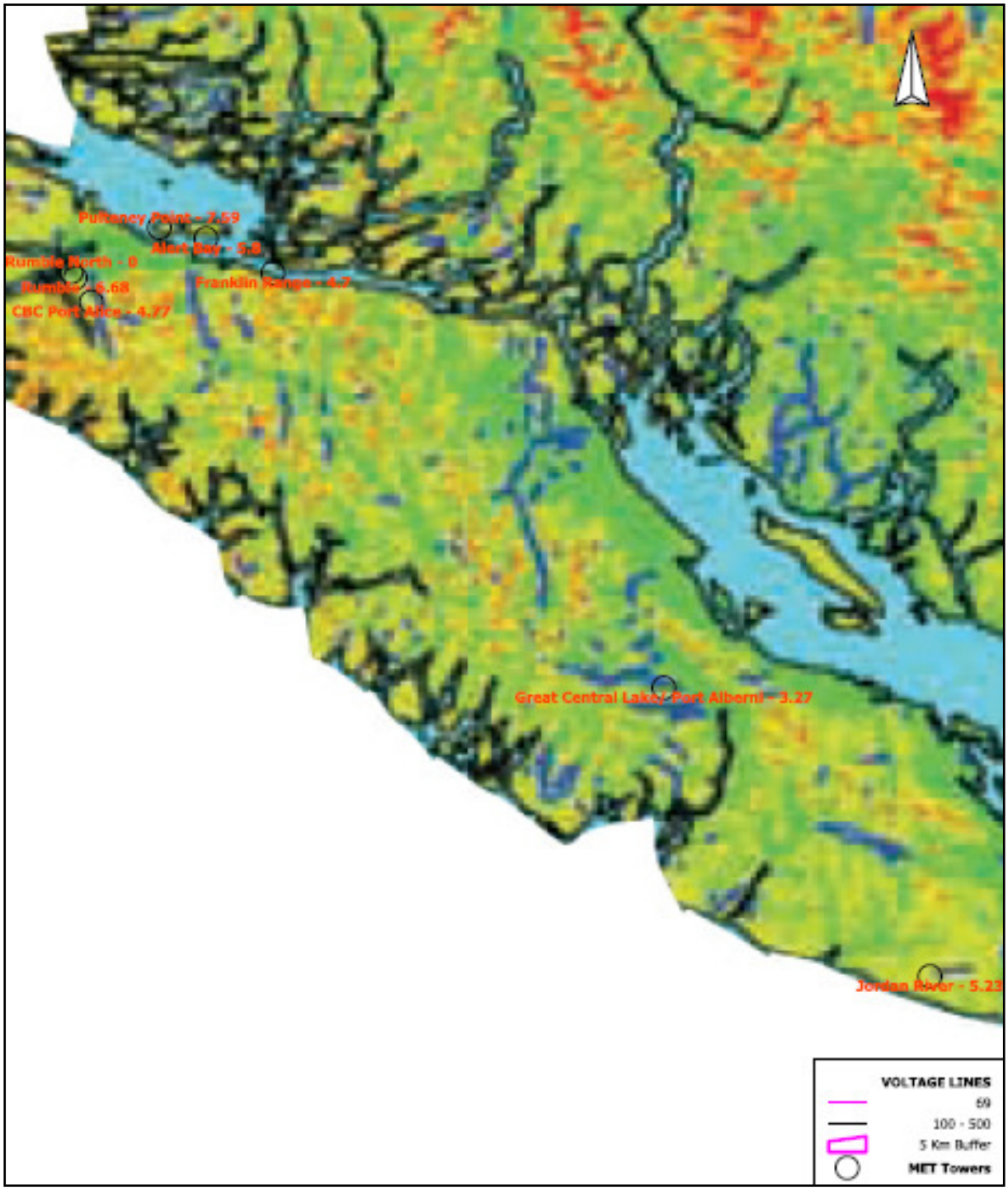

Figure 5.1 Monitoring stations overlaid on modeled map on Vancouver Island.

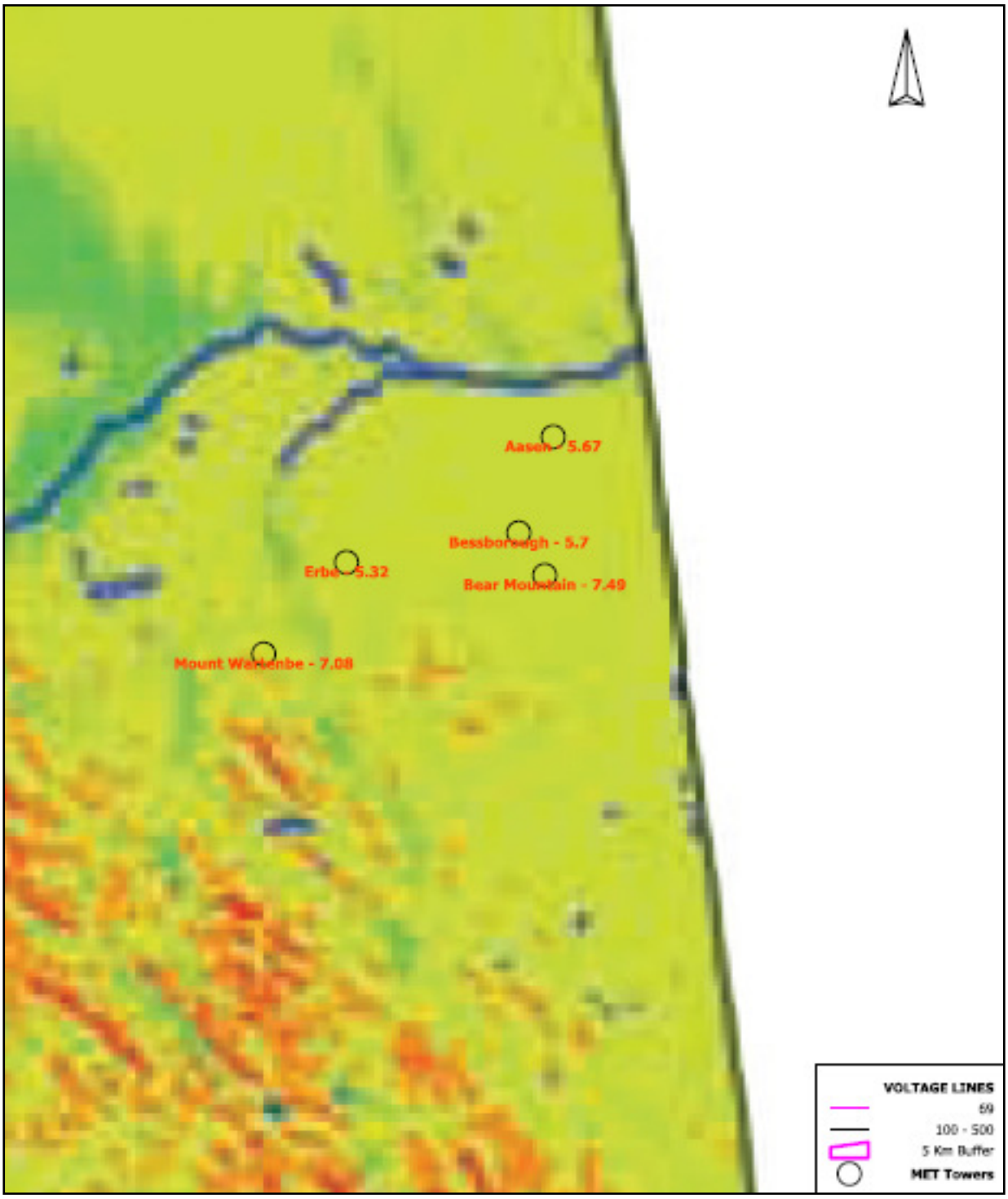

Figure 5.2 Monitoring stations overlaid on modeled map in the Peace Region.

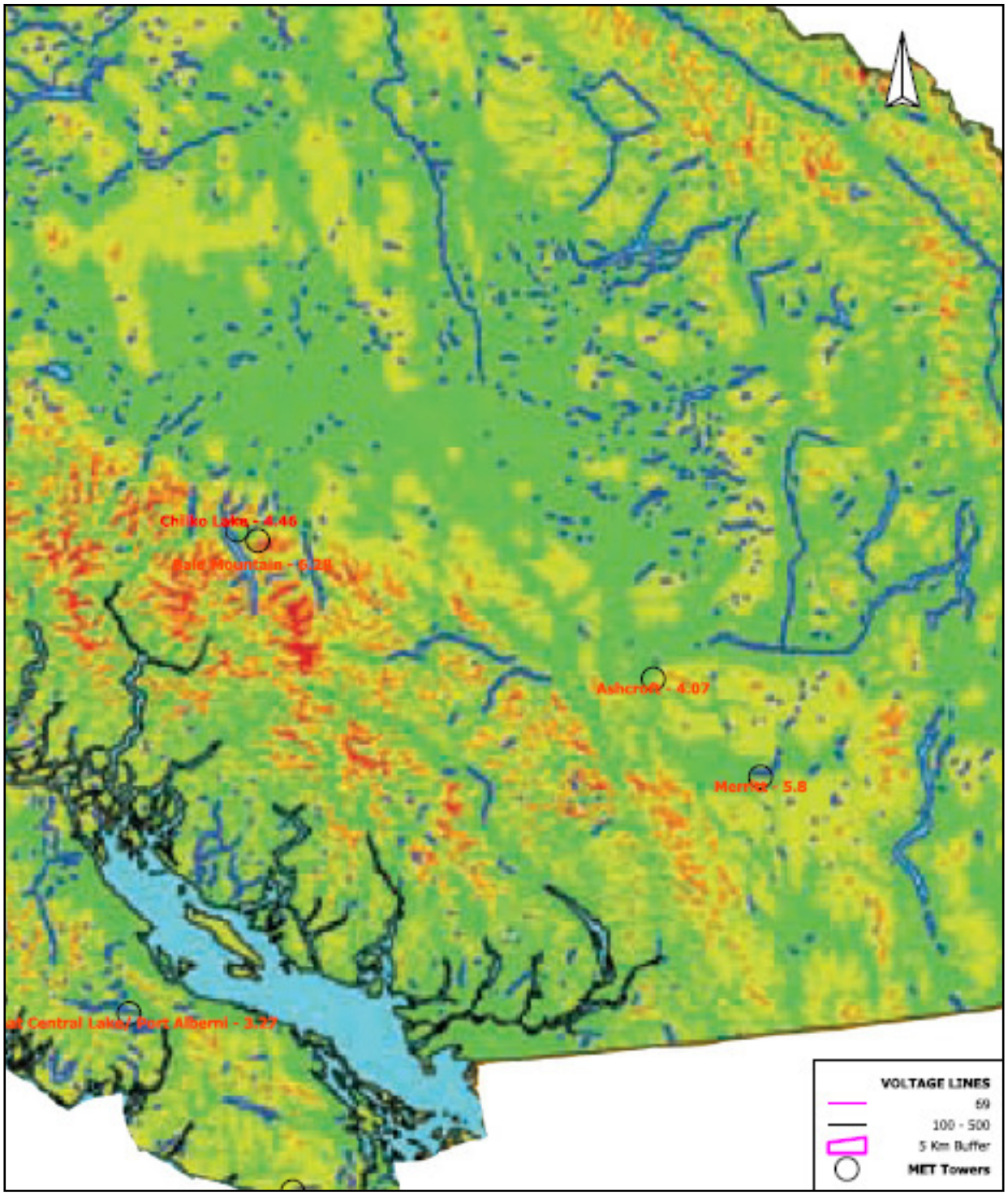

Figure 5.3 Monitoring stations overlaid on modeled map in the Eastern and Southern Interior Region

A visual inspection was performed to identify the predicted annual average wind speed at each monitoring station according to the BC Predicted Wind Speed Map legend. The wind speed range observed at the centre of the MET tower location circles was used. These values were noted and compared to calculated annual average wind speeds from Chapter 4. The results are presented in **Table 5.1**.

Table 5.1 Comparison of modeled annual average predicted wind speed to measured wind speed

Site Name	Region	Measured Wind Speed @ 65 m (m/s)	Modeled Wind Speed Range @ 65 m (m/s)	Does measured wind speed fit in modeled range (Y/N)
Bald Mountain	Interior	6.28	6 to 8	Y
Chilko Lake	Interior	4.46	4 to 6	Y
Merritt	Interior	5.80	4 to 6	Y
Ashcroft	Interior	4.07	4 to 6	Y
Mount Hays	North Coast	Removed from data set		n/a
Bear Mountain	Peace Region	7.49	4 to 6	N (too high)
Bessborough	Peace Region	5.70	4 to 6	Y
Aasen	Peace Region	5.67	4 to 6	Y
Erbe	Peace Region	5.32	4 to 6	Y
Mount Wartenbe	Peace Region	Removed from data set		n/a
Alert Bay	Vancouver Island	5.80	4 to 6	Y
Jordan River	Vancouver Island	5.23	4 to 6	Y
Pulteney Point	Vancouver Island	Removed from data set		n/a
Port Alice	Vancouver Island	4.77	4 to 6	Y
Great Central Lake	Vancouver Island	3.27	<4	Y
Rumble	Vancouver Island	6.68	4 to 6	N (too high)
Rumble North	Vancouver Island	Removed from data set		n/a
Franklin Range	Vancouver Island	4.70	4 to 6	Y

The wind speeds measured at the monitoring stations fit within the range of the predicted wind speed model at 12 of 14 (86%) sites included in this analysis. In both

cases where the measured wind speed was outside the predicted wind speed range, the model under predicted.

5.3 Conclusion

In addition to the potential inaccuracies in the predicted wind speed map and the collected and adjusted data, another source of imprecision comes from the georeferencing process (*see Chapter 8 – Sources of Error* for more detail). The measured wind speeds have matched the predicted wind speeds at most locations.

A visual inspection of the map has identified that annual average wind speeds comfortably fit within the ranges predicted by the modeled wind speed map at 86% of wind monitoring stations. In those cases where the values fell outside the range, the model underpredicted. It can be said that the model provides a conservative estimate of the local wind speed at the 65m height. Although a comparison was not possible in the North Coast region due to removal of the site from the data set, the ability of the model to predict wind speeds at the remaining sites was sufficient to assume reasonable accuracy of the map in general. Therefore it can be concluded that the BC Predicted Wind Speed Map can be used for prospecting potential wind sites.

Chapter 6.0 – Economic Analysis

6.1 Introduction

The economic feasibility of wind farm projects is dependent on a number of factors, including available wind resource, proximity to the grid, site accessibility, and the value of the power purchase agreement. For this chapter, RETScreen, an economic analysis software program, was used to perform feasibility studies for 10 MW SOP projects (NRCAN, 2005). Analyses have been conducted for each of the four promising regions – Vancouver Island, North Coast, Peace, and Interior regions – to determine the wind speed required for projects signing into 20 or 40 year SOP contracts to achieve 0% or 8% internal rate of return (IRR).

For each analysis, the input wind speed was adjusted until the appropriate IRR was calculated. The IRR was used as a measure to determine the financial viability of a project. The higher the IRR, the more financially viable the project is. A 0% IRR has been chosen to determine wind speeds that will allow the project to break even; this case is only possible where external investment is not required. Based on personal industry experience, an 8% IRR is considered low but reasonable for community-based, small projects to receive financing. The results of these analyses will be applied in the next chapter to identify areas on the BC Wind Map where 10 MW SOP projects could be economically feasible.

Development costs for wind projects in British Columbia are just being realized by developers building the first wind farms that have yet to become operational. Therefore, costs specific to BC are largely unknown, especially those costs for small SOP wind projects. The costs assumed in these analyses are based upon industry experiences when developing 10 MW projects in Ontario. Assumptions that have been made in this analysis are addressed below.

6.1.1 RETScreen the Tool

The RETScreen International Renewable Energy Project Analysis Software was developed by Natural Resources Canada (NRCAN, 2005). It is a feasibility analysis modelling tool that uses a series of spreadsheets in Excel whereby you insert weather, project, costs and other information to assess project feasibility. RETScreen is used by planners and decision-makers in the wind industry. The user can choose from a selection of wind turbine models and manufacturers. Included in the RETScreen package are wind speed distributions that can be chosen to reflect the local wind regime.

6.2 RETScreen Analysis

6.2.1 Introduction

The analyses investigated five Enercon E82 wind turbines at a hub height of 80 meters for a 10 MW sized project suitable for the Standing Offer Program. This is a feasibility study and input variables were the same for each region with the exception of weather information and the avoided cost of energy (power payment price). It is important to

note that costs and financing structure can be expected to vary significantly for individual wind farm projects.

All monetary values are presented in 2008 Canadian dollars.

The RETScreen analysis sheets for each region to acquire 0% and 8% IRR in 20 year and 40 year periods are included in **Appendix C**.

6.2.2 Analysis Discussion

The following sections describe the different worksheets in the RETScreen Excel model. Some sections include a table summarising the input values and assumptions for their use.

6.2.2.1 Energy Model

The energy model section was adjusted to represent known or modeled site characteristics. Wind speeds were adjusted as the analysis required (meeting 0% and 8% IRR). **Table 6.1** displays the input values in the energy model section and provides a justification of values.

Table 6.1 Values and assumptions summary for RETScreen energy model section.

Section and Heading	Value	Justifications, Assumptions, and Comments
Site Conditions		
Annual average wind speed	variable	Adjusted to reach IRR goals
Wind shear exponent	0.2	Appropriate value for rough terrain. (also found to be average value for monitoring stations)
Average atmospheric pressure Vancouver Island North Coast Eastern and Southern Interior Peace Region	 98 kPa 97 kPa 88 kPa 91 kPa	Based on RETScreen Database- Average pressure was calculated for each region using all regional weather stations from database
Annual average temperature Vancouver Island North Coast Eastern and Southern Interior Peace Region	 9 °C 5 °C 4 °C 1 °C	Based on RETScreen Database- Average temperature was calculated for each region using all regional weather stations from database
System Characteristics		
Grid type	Central-Grid	Requirement of SOP
Array losses	5%	No other turbines present
Airfoil soiling and/or icing losses	2%	Typical value for areas not heavily influenced by waterbodies
Other downtime losses	2%	Typical value, but could later be refined by manufacturer based on maintenance contract
Miscellaneous losses	4%	Assumed losses due to unforeseen circumstances

6.2.2.2 Equipment Data

The equipment data page summarizes the technical characteristics specific to the chosen turbine. The turbine details as well as its associated power curve were taken from the manufacturer's website and input into RETScreen.

The equipment used in the analyses is the Enercon E82 turbine. It is a 2 MW turbine with a rotor blade diameter of 82 m, a swept area of 5281 m^2, and hub height of 80 m. A Weibull shape factor, k-factor, of 2.5 was used and considered suitable because it

represents a value that lies between inland and coastal regions. The k-factor is expected to vary between different potential sites. Furthermore, the same average wind speed can have very different wind speed distributions. The decision to assume the same k-factor of 2.5 for all potential sites was made due to time restraints; the complexity of analysis to determine an accurate k-factor for each region would have required more time than was available.

6.2.2.3 Cost Analysis

The values in the cost analysis were derived from either industry standards[1] or quotes from hardware manufacturers. Estimated costs are subject to uncertainty and variability of hardware availability, cost of raw materials, and currency exchange rates. The costs used in the RETScreen analyses represent current economics and exchange rates. RETScreen divides the analysis into subsections according to when the cost is incurred. A description of the types of costs in the cost analysis section is provided below, while input values and the reasoning behind them are provided in summary **Table 6.2**.

Capital Costs

The first subsection of the capital costs are those fees associated with the feasibility study. This section corresponds to the consulting fees for the project. The values were taken from standard engineering contracts between developers and a competitive consulting company in Ontario. Development and Engineering costs represent the stage

[1] Industry standards were learned by the author while working for Wind Energy Engineering consulting company based in Ontario with an office in BC with current experience in prospecting.

of the project prior to construction. Items such as permitting, project management consulting, and detailed engineering work are included in this section.

The costs presented in the Energy Equipment and Balance of Plant sections were part of a package provided by Enercon including many of the construction details, such as foundation, turbine erection, and geotechnical investigation.

Annual Costs

Annual costs represent the expenses that a project will incur every year. Enercon provides a 12 year maintenance package that is a function of power produced. Other expenses include insurance, land use costs, and site visits.

Periodic Costs

Periodic costs are large recurring lump sum costs associated with replacement of machinery and major repair work such as delamination.

Table 6.2 Values and assumptions summary for RETScreen cost analysis section.

Section and Heading	Value	Justifications, Assumptions, and Comments
Initial Costs		
Feasibility Study		
Site investigation	8,000	Based on site-appropriate consulting fees
Wind resource assessment	55,000	Based on site-appropriate consulting fees
Environmental assessment	160,000	Based on site-appropriate consulting fees - Includes cost associated with pre and post construction monitoring
Preliminary design	25,000	Based on site-appropriate consulting fees
Detailed cost estimate	21,000	Based on site-appropriate consulting
Project management	10,000	Based on site-appropriate consulting fees
Development		
PPA negotiation	15,000	Assumes time required to obtain Standing Offer Contract (based on similar process in Ontario)
Permits and approvals	80,000	Includes Zoning & Official Plan Amendments, Ministry of Transportation Applications, Crown Land applications, potential payments to First Nations groups, and Consultation Time
Land survey	6,000	Cost associated with survey, admin, etc.
Project financing	6,000	Assumes financing will be arranged "In-House" by developers
Legal and accounting	12,000	Includes turbine purchase contract & negotiation, maintenance contract & negotiation
Project management	45,000	Assumes task will be handled by consultant
Travel and accommodation	10,000	For development admin, etc
Engineering		
Wind turbine(s) micro-siting	5,000	Assumes turbine location will be established after Feasibility Study is complete
Mechanical design	-	Limited to a review of plans/specs determined by Enercon as part of "Turnkey" type package
Electrical design	100,000	Based on industry experience in Ontario
Civil design	25,000	Foundation and Design Included in Enercon as part of "Turnkey" type package. Cost associated with consultation review of soil and road spec.
Tenders and contracting	15,000	Assumes some difficulty due to small size of project. Assumes one general all-purpose wind energy construction contractor.
Construction supervision	90,000	Assumes 5 months of construction of road/consultation/site trips

continued...

Table 6.2 con't

Section and Heading	Value	Justifications, Assumptions, and Comments
Initial Costs		
Energy Equipment		
Wind turbine(s)	2,340,000 per MW	Based on quote from Enercon
Transportation	-	Included in turbine cost
Balance of Plant		
Road construction	240,000	Est. based on 6 km of road and a cost of $45,000 / km
Transmission line	725,000	Est. based on 5 km to grid connection and a cost of $145,000/km (5 km utilized in scope of Chapter 7)
Substation	180,000	Substation Costs - Typical for a single substation in Ontario (one substation assumed to connect to 69 kV or lower line – this utilized in scope of Chapter 7).
HONI Costs	500,000	Cost covers BC Hydro upgrade costs - conservative estimate based on Ontario experience
Miscellaneous		
Training	12,000	Estimated value, external to what Enercon provides (SCADA, Switchhouse Maintenance)
Commissioning	20,000	Cost associated with public opening, technical review by BC Hydro, etc.
Contingencies	515,300	Assumed 2% of annual costs
Interest during construction	328,504	Assumed 5 months of construction at 6% interest
Annual Costs		
O & M		
Land lease	5,000	Assumed 2% of gross revenue (GH, 2008)
Property taxes	22,000	Project assumed to be on Crown Land where federal taxes do not apply. However land will also be part of Regional District where taxes would likely apply. A conservative estimate applied here based on Ontario experience.
Insurance premium	50,000	Based on an estimate of 10,000 per turbine, (Industry Standard, reduction due to O&M package).
Transmission line maintenance	9,050	Based on an industry standard of 1% of total cost of lines. Assumes proponent owns line.
Parts and labour	92,911	Covers the cost of telecom and SCADA
Travel and accommodation	3,000	Cost of traveling to Site per year
General and administrative	16,377	Assumption for operation of farm/re-occuring consultation costs
Other - O&M	varies with wind speed	Cost of Enercon's O&M plan, assumes 1.48 exchange rate, O&M a function of power output (Enercon price quote)
Contingencies	varies with wind speed	Assumes 4% of annual costs

continued...

Table 6.2 Concluded.

Section and Heading	Value ($CAN)	Justifications, Assumptions, and Comments
Periodic Costs		
Blade Repair	500,000	Every 15 years blade maintenance is conducted and one blade replaced (assumes $250,000 for blade replacement and $250,000 of blade repair over 15 years)
Turbines	23,400,000	Every 21 years turbines (10 MW) need to be replaced

6.2.1.4 RETScreen – Financial Summary

The input parameters in this section of the RETScreen analysis include the project life, inflation and avoided cost of energy. The project life was adjusted to 20 and 40 years to match the two options for potential SOP contract periods. The wind speed was also adjusted to achieve an IRR of 0% or 8%.

The SOP payment and EERP funding parameters were input in this section. The base price in the SOP ranges depended on project location (*see Section 2.5.2 – BC SOP*). An additional Environmental Attributes Price is also available for projects that receive Environmental Certification. This additional price was included for this analysis, however not all developers will be eligible for this additional payment. Final prices depend on time of delivery – diurnal and monthly which were not taken into consideration in this analysis. Escalation rates for diurnal and monthly periods were all averaged together. The average value for all the escalation adjustments was 100%, therefore only the base rates, excluding any escalation, were considered in the financial analyses. The total of the regional base price plus the Environmental Attributes price was input for the *avoided cost of energy*. The ecoENERGY funding was input for the *RE*

production credit. The RE production credit duration is terminated after 10 years and was reflected in the analysis. **Table 6.3** displays the input values for the financial summary section and provides a justification of values.

Table 6.3 Values and assumptions summary for RETScreen financial summary section.

Section and Heading	Value	Justifications, Assumptions, and Comments
Avoided cost of energy Vancouver Island North Coast Eastern and Southern Interior Peace Region	 0.08733 $/kWh 0.07447 $/kWh 0.07537 $/kWh 0.07304 $/kWh	 Assumes regional Standing Offer + Environmental Attributes Payment Prices
EERP Funding	0.01 $/kWh	Assumes EERP funding
Energy cost escalation rate	0.5%	Based on Standard Offer Program Rules
Inflation	2.50%	Standard Assumption
Discount rate	10%	Standard Assumption
Project life	20 and 40 years	According to SOP terms
Debt Ratio	75%	Assumed
Debt Interest Rate	7.0%	Assumed
Debt Term	15 years	Assumed

6.2.3 Base Case Results

The regional wind speeds that were found to achieve IRRs of 0% and 8% in 20 and 40 year terms are summarised in **Table 6.4**. In all cases, lower wind speeds were able to reach the IRR goals in 20 year terms compared to 40 year terms. Lower wind speeds were profitable on Vancouver Island compared to the other regions and had the highest payment price. However, the relationship between payment price and wind speed was not found to be inversely proportional as was expected having input identical costs into RETScreen. (*see section 6.3 Discussion*). For example, the Southern and Eastern Interior

region required the highest wind speeds to reach IRR goals but had the second highest payment price of all regions.

Table 6.4 Summary of wind speeds to achieve 0% and 8% IRRs in 20 and 40 year SOP terms.

		Wind Speed (m/s) at 65 metres (scaled to using the power law)				
	Expected IRR	IRR = 0%		IRR = 8%		**SOP Payment Price ($/kWh)**
	Contract term	20 years	40 years	20 years	40 years	
Region	Vancouver Island	6.7	7.1	7.5	8	0.08733
	North Coast	7.5	8.1	8.5	9.4	0.07447
	Southern and Eastern Interior	7.9	8.6	9.1	10.3	0.07537
	Peace	7.8	8.7	9.1	10.3	0.07304

6.2.4 Sensitivity Analysis

RETScreen was used to conduct a sensitivity analysis for each scenario to determine how SOP payment price and project lifetime affect the financial outcome. While the financial inputs into the RETScreen model were based on industry standards and educated approximations, it is still reasonable to expect some inaccuracy with assumptions and variations in costs from project to project. The sensitivity analysis is a valuable tool that can reveal significant sensitivities of a project to particular variables.

The sensitivity analysis looked at percent changes in capital costs and annual costs compared to changes in the avoided cost of energy. **Table 6.5** shows the IRR for a 10% increase in payment price, a decrease of 10% in the capital costs and a decrease of 10% in the annual costs.

Table 6.5 Sensitivity analysis of payment price, capital, and annual costs.

	Vancouver Island (base pay = 0.0873)				North Coast (base pay = 0.0745)				Southern and Eastern Interior (base pay = 0.0754)				Peace (base pay = 0.073)			
Project Lifetime	20	40	20	40	20	40	20	40	20	40	20	40	20	40	20	40
Base Case IRR (%)	0.4	0.6	8.1	7.9	0.7	0.2	7.9	8	0.6	0.2	7.9	8.1	-0.4	0.4	8.1	8.3
Payment Price increased by 10% (IRR (%))	4.6	4.4	13.2	15.8	5.3	4.9	13.4	17.3	5.2	4.7	13.3	17.3	2.9	5.5	13.6	17.7
Capital Costs reduced by 10% (IRR (%))	3.9	2	12.6	14.1	4.4	1.7	12.6	15.4	4.3	1.7	12.6	15.4	3.9	2.1	12.8	15.8
Annual Costs reduced by 10% (IRR (%))	1.7	1.8	9.6	10.3	2.3	2	9.7	11.4	2.2	1.9	9.7	11.4	2.5	2.3	10	11.8

The sensitivities analyses of each scenario produced nearly identical results in all studied regions. A review of the sensitivity analysis revealed that scenarios were more sensitive to payment price rather than initial costs and more sensitive to initial costs than annual costs.

6.3 Discussion

The RETScreen analysis revealed that Vancouver Island, the region eligible for the greatest payment price in the SOP, has the greatest potential for reaching IRR goals at lower wind speeds. An interesting observation was that the payment price did not relate inversely to project profitability; while the payment price for the remaining three studied regions were quite similar to each other, the highest of the three, the eastern and southern interior region, required the greatest wind speeds to reach IRR goals. This observation can be explained by regional variations in atmospheric pressure. In regions

with higher atmospheric pressure, such as the coastal and lowland regions of Vancouver Island and the North Coast, there is more energy in the wind used by the turbine. Consequently, the inland, often mountainous Southern and Eastern Interior region with an average annual atmospheric pressure of approximately 88 kPa required greater wind speeds than the higher pressure Peace region (atmospheric pressure of 91 kPa) and North Coast region (atmospheric pressure of 97 kPa) that receive lower power payment prices to reach IRR goals. Vancouver Island has several variables that promote potential wind farm developments – higher power payment price and higher atmospheric pressure.

The RETScreen analysis revealed that the 20-year SOP contract terms with BC Hydro were more profitable than 40-year terms. This was largely due to the removal of the EERP payment of one cent per kilowatt hour after year ten; the cost of replacing the turbines in year 21 was not recovered as quickly with a reduced power payment price.

Finally, the sensitivity analysis indicated the sensitivity of the project feasibility to SOP payment price and costs. The greatest sensitivity was to the payment price. An 8% IRR is considered quite low for financing of a commercial project, but was considered reasonable for the scale of SOP projects and the purpose of the program. However, this analysis revealed that a slight increase in the payment price can make a marginal project much more realistic. For example, an increase in the payment price for Vancouver Island from $8.73/MWh to $9.713/MWh increased the IRR from 8.1% to 13.2% in a 20-year term. Therefore, an increase in the price BC Hydro is offering in the SOP would

be essential to encourage developers to consider projects that will undoubtedly have difficulty inspiring investment if the price remains the same.

Chapter 7.0 – SOP Site Prospecting

7.1 Introduction

The purpose of this chapter is to utilise the BC Predicted Wind Speed Map to identify prospective SOP wind project sites in the different regions using the findings of the financial analysis. The financial analysis revealed the wind speeds required to achieve internal rates of return of 0% and 8% if participating in the BC Hydro Standing Offer Program. The map was then used to locate where wind speeds are high enough to make a project economically feasible. The prospective areas are listed and illustrated in tables and figures below.

7.2 Prospecting Scope

In order to conduct the prospecting, several project characteristics were assumed to keep project costs down and to narrow the scope of the exercise. To reduce construction costs, it was assumed that the project would connect to the 69 kV transmission line and therefore require only a single substation to step up the power generated by the wind farm. Connection to distribution lines was not considered because it would have been too costly and time-consuming to acquire this information for the purposes of this report. It was also assumed that the project would be located within 5 km of the 69 kV transmission line in order to reduce the costs for the electrical tap line. Increasing the distance from the grid increases transmission costs as well as electrical losses. Studies have suggested that a wind farm must be within 16 km of transmission lines, while it is ideal the proximity to be within 800 m (University of

Nebraska, 1996; Wasatch Wind, 2004). Accordingly, a 5 km buffer area representing the maximum distance to the 69 kV transmission line has been used in the figures in the following section. Finally, the four promising regions – Vancouver Island, North Coast, Peace, and Eastern and Southern Interior – were the areas of focus.

7.3 Prospective areas in promising regions

The basis for regional prospecting of wind sites was the development of a map. Manifold GIS Software was used to overlay the 69 kV transmission lines acquired from BCTC onto the BC Wind Atlas. A 5 km buffer was generated around the transmission lines. A visual inspection was conducted to locate the wind speeds listed in **Table 6.4** within the buffered area using the wind speed range legend. Initial inspection indicated that wind speeds above 8 m/s at 65 metres did not exist anywhere near to the 69 kV transmission line. This immediately excluded projects that could produce an 8% IRR under any contract duration or 0% IRR under a 40-year contract, with the exception of Vancouver Island. Only eight potential locations, two in each region were identified as prospective areas for wind projects in BC under the SOP that could produce a 0% IRR or 8% IRR. The approximate centre point of these areas, the topography of the area, and the nearest town are listed in **Table 7.1**.

Table 7.1 Prospective wind project sites in BC under SOP.

Region (IRR%)	Coordinates		Nearest Town	Topography
	Lat	Long		
Vancouver Island (0% and 8%)	50 41.94	-127 33.73	Port Hardy	Coastal Forested Ridge
	48 49.57	-124 0.15	Lake Cowichen	Forested Ridge
North Coast (0%)	54 6.558	-129 51.277	Port Essington	Mountain Range
	54 15.01	-130 19.53	Ridley	Coastal Forested Ridge
Peace Region (0%)	53 52.14	-123 28.35	Telechick	Fragmented Inland Forest
	53 56.47	-122 28.876	Bonnet Hill	Forested Hills
Southern and Eastern Interior (0%)	50 55.611	-122 34.36	Kamloops	Mountain Range
	49 33.27	-114 54 .59	East Kootenay	Mountain Range

The prospective areas for wind development in the Vancouver Island, North Coast, Peace and Southern and Interior regions are displayed in **Figures 7.1**, **7.2**, **7.3**, and **7.4** respectively. A white circle has been used to guide the viewer to the locations on the maps. The prospective areas are appropriately located near the coast and/or on ridges or mountaintops. In reality, the steepness of the terrain will influence the selection of suitable sites, however the logistics of this were not considered in this study.

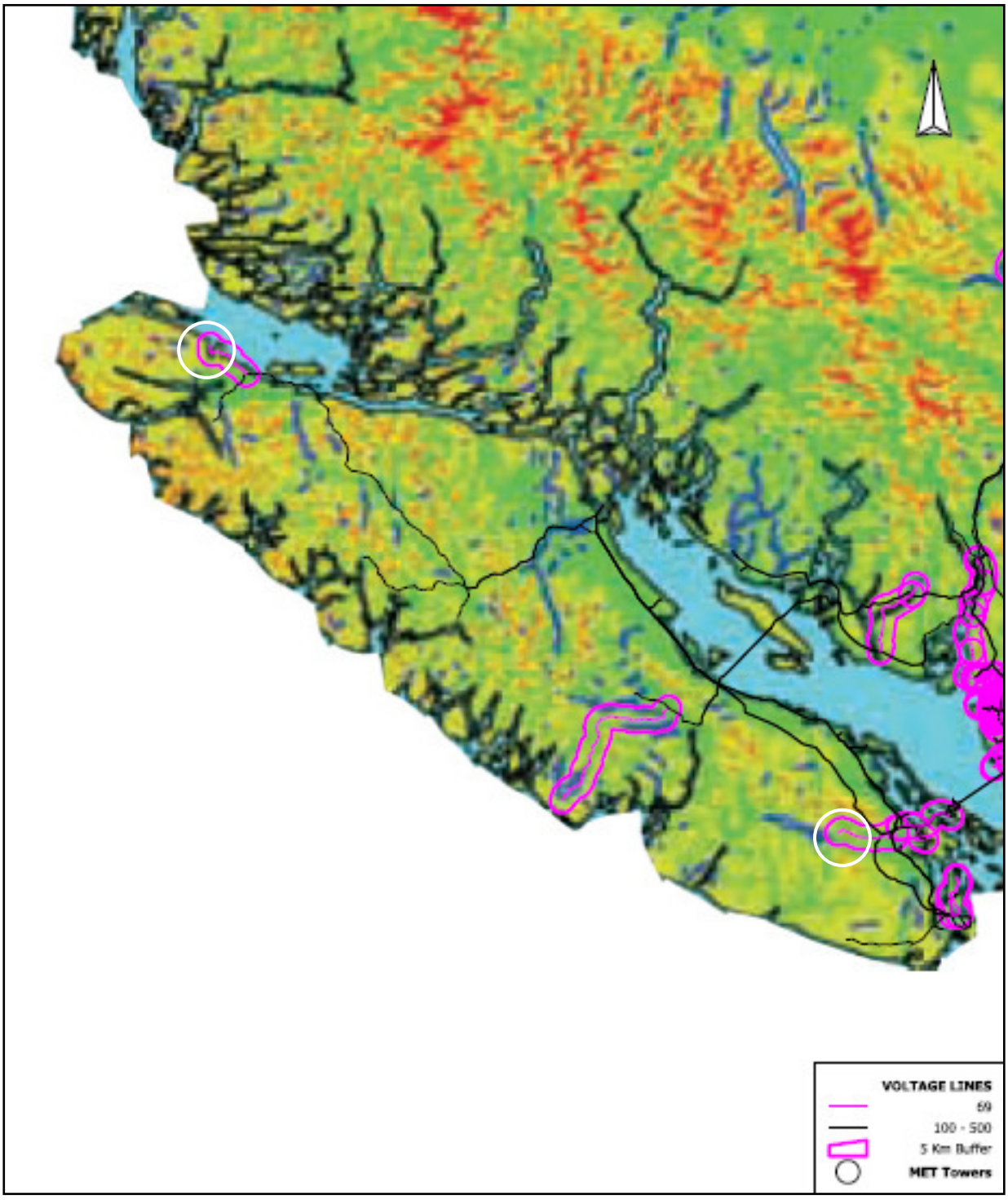

Figure 7.1 Prospecting in Vancouver Island.

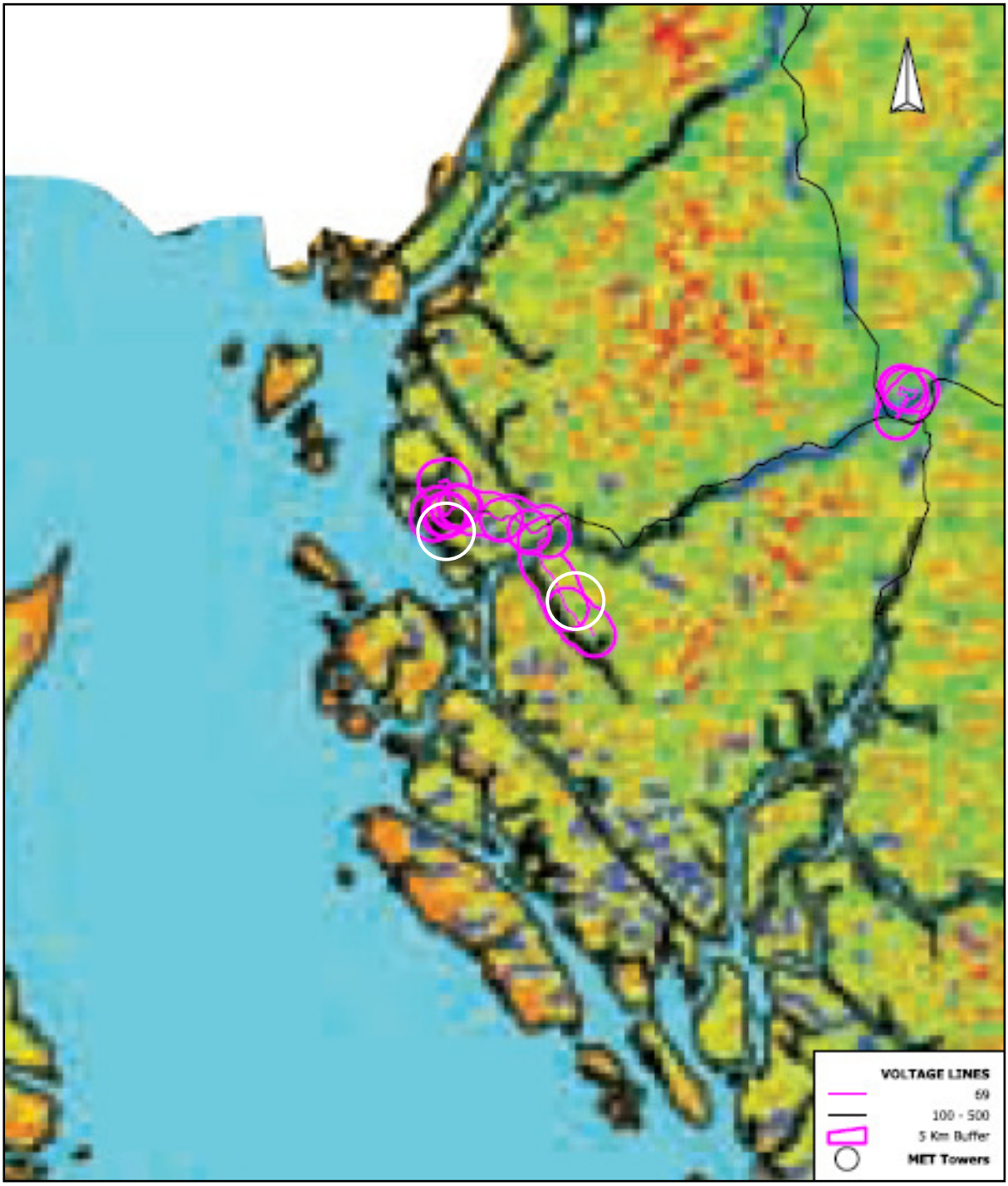

Figure 7.2 Prospecting in the North Coast.

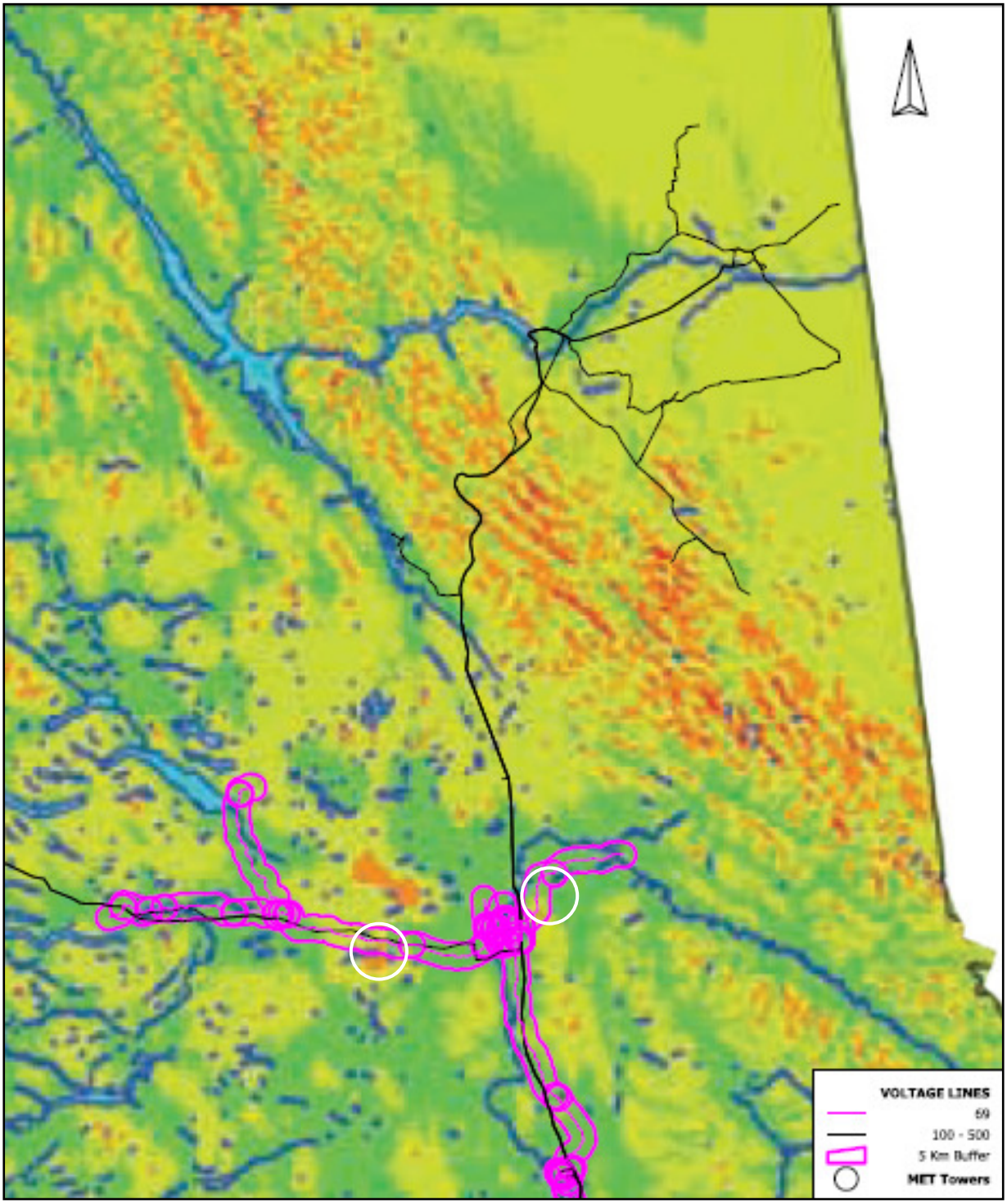

Figure 7.3 Prospecting in the Peace Region.

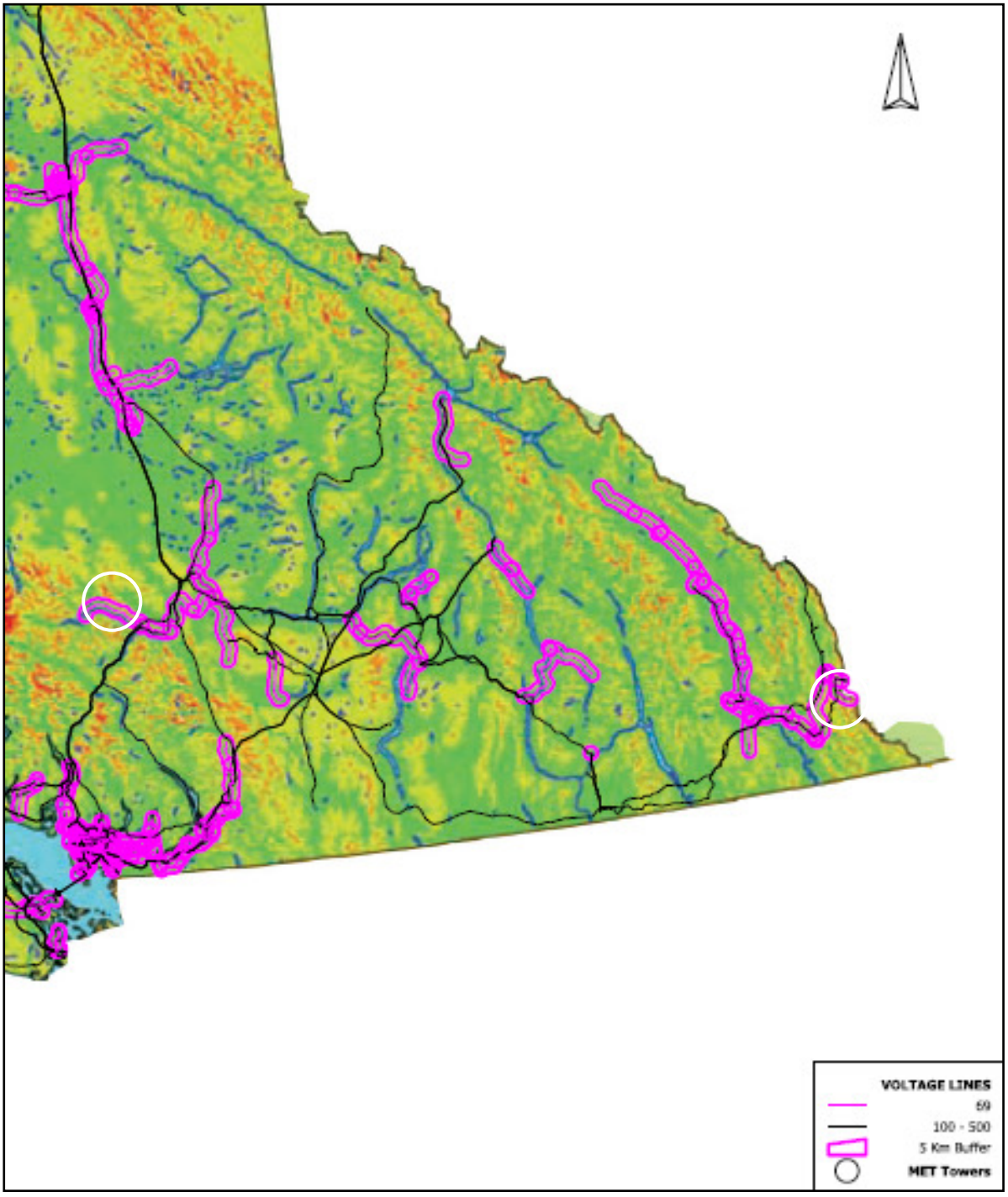

Figure 7.4 Prospecting in the Eastern and Southern Interior region.

Chapter 8 – Sources of Error

8.1 Introduction

The assumptions made and equipment utilized and referenced in this report have inevitably introduced error into the study. The potential sources of error that exist relate to the MesoMap system, monitoring equipment used in data collection, wind shear calculations, and the georeferencing process. These sources of error are briefly discussed in the following sections.

8.2 MesoMap System

The MesoMap system has been validated and tested more widely than any other wind mapping system currently in use (AWST, ?b). Independent testing and validation of the MesoMap system has determined mean wind speed accuracy typically in the range of 5-7%. To produce the BC map, a very large area was studied which automatically introduces potential for error each time data is manipulated. Some other sources of error include uncertainty of surface property assumptions and errors in the land cover databases (AWST, ?). Therefore, there is assumed to be some inaccuracy in the resolution of the model.

8.3 Monitoring Equipment

The accuracy of the calculated annual average wind speeds at monitoring stations was inevitably reduced by measurement system accuracy. The specifications for accuracy of the meteorological equipment as indicated by the manufacturer were assumed to be met during the data collection program coordinated by BC Hydro. The accuracy of each type of sensor is outlined in **Table 8.1**. The cumulative errors that could have existed in the monitoring systems at maximum specified inaccuracy would not have had significant impacts on the accuracy of collected data.

Table 8.1 Accuracy of Monitoring Equipment used at Monitoring Stations

Equipment Type	Accuracy	Summary of Accuracy (if available/required)
Campbell Scientific (CS) CR10 datalogger	± 0.2% of FSR (full scale range) (CS, 1992)	
CS CR10X datalogger	± 0.14% (CS, 2006)	Sum of analog input: ± 0.1% of Resistance measurements: ± 0.03% of FSR, and Period averaging measurements: ± 0.01% of reading
CS CR510	±0.13% (CS, 2004)	Sum of analog input: ± 0.1% of FSR Resistance measurements: ± 0.02% of FSR, and Period averaging measurements: ± 0.01% of reading
NRG Symphonie datalogger	0.1% of FS (1024 counts) (NRG, 2008a)	
NRG Maximum #40 anemometer	To within 0.1 m/s for wind speed range 5 m/s to 25 m/s (NRG, 2007a)	
NRG #200P vane	Potentiometer linearity within 1% (NRG, 2004)	
CS - RM Young WindMonitor	Wind Speed: ±0.2 m/s (or 1% of reading) Wind direction: ±3° (CS, 2007a)	

Continued...

Table 8.1 concluded.

CS 107 Temperature sensor (in shield)	Steinhart-Hart Error: <±0.01°C (-35° to +50°C) Interchangeability error: <±0.2°C (0° to +50°C) increasing to ±0.4°C at -40°C (CS, 2007b)	
NRG #110S temperature sensor (in shield)	Total error ± 1.1 °C maximum (NRG, 2007b)	Offset: ± 0.8 °C maximum Nonlinearity: ± 0.33 °C maximum
NRG #BP20 Barometer	± 1.5 kPa (15 mb) max. uncorrected offset (NRG, 2008b)	
NRG relative humidity sensor	± 5% RH from 5 to 95% RH (at 25 °C) (NRG, 2007c)	
NRG IceFree III heated Anemometer	99.7% of sensors fall within 4.3% of stated transfer function (based on over 800 samples) (NRG, 2004)	

8.4 Collected Data Quality

Data sets from all monitoring stations produced data recovery rates between 97% and 100%. Compounded with the potential for reduced accuracy from monitoring station equipment as identified in **Table 8.1** above, the data quality was still considered high for this report.

8.5 Wind Shear Calculations

Wind shear calculations were used to adjust the candidate data to a 65 metre hub height in order to compare values to ranges illustrated in the BC Predicted Wind Speed Map. The wind shear calculations used the following power law expression: $v / v_o = (h / h_o)^{\alpha}$. The resultant mean wind speeds at hub height can be inaccurately predicted when using

such a power law; errors can be compounded in logged data by extrapolation. In this report, the potential for compounding error introduced by assuming a value for α was reduced in twelve of the fourteen monitoring stations analysed in this report because they were calculated based on collected data from sensors at two heights and not assumed.

8.6 Georeferencing

Another source of imprecision could have been introduced by the georeferencing process. Georeferencing was used when the modeled map was georegistered in Manifold GIS software using known coordinates throughout the province. The exact amount of error that was introduced by this process is difficult to quantify, however a visual inspection of land features such as mountains, rivers, and island boundaries on both the BC Predicted Wind Speed Map and Google Earth demonstrated that they lined up impressively.

Chapter 9 - Discussion

The analyses in this report have revealed the weakness of the BC Hydro Standing Offer Program with its current payment prices. Very few potential sites for wind power development were identified in the regions of British Columbia acknowledged as having the greatest potential. The average annual wind speeds that would be required to attain a reasonable return on investment are exceptionally high. The Ontario Power Authority initiated a very similar program called the Standard Offer Program in May, 2007 for projects up to 10 MW (OPA, 2008). In comparison to the BC SOP, projects in Ontario are paid a base rate of 11 cents per kilowatt hour with the opportunity for an additional 3.52 cents per kilowatt hour for projects that can demonstrate their reliability to deliver power during peak hours. There has been greater than expected interest in this program that has left the regulator scrambling to catch up and limiting development while transmission line upgrades are completed. The positive reception of the program reflects the developer's satisfaction with the payment price. If they are seriously interested in promoting green energy and achieving their "vision for clean energy leadership", an increase in the payment price of the SOP is required. Developing wind projects not only produces power using a clean and renewable resource to contribute to a diversified energy mix; it also can benefit BC by creating jobs creation and strengthening rural economies.

9.1 Further Work

The analyses conducted in this report were limited by assumptions that were made in light of the duration to complete them and by budgetary constraints – namely to acquire maps and collected data. In the absence of deadlines and with greater access to resources, the following work could be performed to complete a more thorough and detailed study on the feasibility of the BC Hydro SOP:

- Analysis of all eight regions being offered variable base payment prices under the SOP;
- Acquisition and analysis of long-term meteorological data collected from more monitored sites throughout BC to compare with model;
    - Improve strength in verification of modeled map with collected data;
- Comparison of collected meteorological data with new mesoscale wind data study commissioned by BC Hydro;
- Analysis of other characteristics of wind in addition to wind speed – specifically wind direction to assess predominant wind regimes;
- Completion of additional RETScreen analyses to include all regions;
- Assessment of a variety of wind distribution k-factors to determine effect on RETScreen feasibility analyses;
- Additional prospecting to assess connections of wind projects of variable distances to a variety of transmission and distribution lines;

- Consultation with developers and government representatives to gain insight into impressions of the SOP and ideas for improvement;

- Detailed discussion on ideas for improving the SOP and the feasibility of those ideas.

Chapter 10 – Conclusion and Recommendations

The financial analysis revealed that the BC Hydro Standing Offer Program does not provide an adequate payment price to encourage development of small wind projects. Unless a developer can acquire turbines at a greatly reduced cost, there is currently very limited opportunity for small wind projects in the province. Vancouver Island does hold some promise being the only region with great wind speed potential and high enough payment price to produce an 8% IRR. An 8% IRR is considered relatively low from the perspective of the bank, but was considered in this report as a lower range suitable for smaller, community-based projects. Realistically, the IRR would be required to be at least 12% to be considered for project financing. Consequently, sites identified as having the potential to generate enough power to break even financially (0% IRR) could not even be considered at present unless the developer had a personal source of funding. The revelation that funding a small wind farm under the SOP is inherently prohibitive contradicts the spirit of a program that was intended to encourage construction of community-based projects. It is highly recommended that BC Hydro increase the base payment prices to at least 11 cents per kilowatt hour at the two year review period, if not sooner.

The BC Predicted Wind Speed Atlas can be used by developers with confidence as a preliminary prospecting tool for identifying areas of good wind potential to initiate assessment. On its own it does not reach its full potential, but when coupled with transmission lines, as was done in this report, the developer has the ability to narrow their search to regions that are within a reasonable proximity to the grid. Developers

seriously interested in constructing a wind project in BC should conduct analyses with greater resolution maps and at least one year of data collected on-site to investigate potential areas in greater detail.

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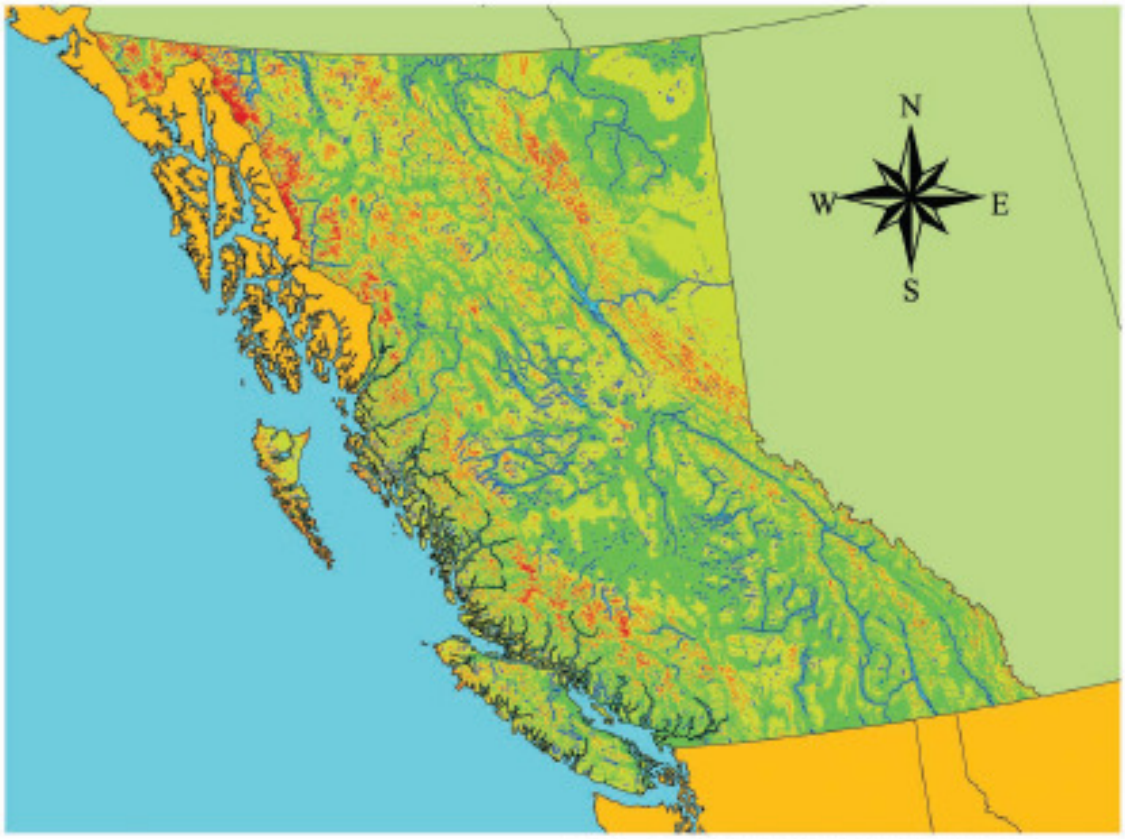
APPENDIX A

British Columbia Predicted Wind Speed Map

British Columbia
Predicted Wind Speed Map



100 0 100 200 300 400 Kilometers

Legend

- Canada
- Pacific Ocean
- USA
- Lakes

Predicted Wind Resource Quality
(Annual Average Wind Speed at 65 m (m/s))

- Poor < 4 m/s
- Fair 4 to 6 m/s
- Good 6 to 8 m/s
- Very Good > 8 m/s
- No Data

Wind energy maps are available through the
Canadian Cartographics Ltd at http://www.canmap.com/green.htm

Projection: Universal Transverse Mercator (Zone 9)
Spatial Resolution of the Wind Resource Data: 1000m
Height above ground surface of predicted wind speed data: 65m

This wind resource map of British Columbia was developed for BC Hydro by TrueWind Solutions using the MesoMap system, a dynamic atmospheric simulation model, and historical weather data.

This map was generated using mathematical models and illustrates general wind velocities for informational purposes only. Wind speed and direction may vary. Consult a qualified professional before relying on the information expressed on this map.

BC hydro

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APPENDIX B

BC Hydro Monitoring Station Equipment

Appendix B: BC Hydro Monitoring Station Location Equipment (BC Hydro, 2004).

	Tower	Datalogger	Power Supply	Communications	Wind Sensors	Other Sensors
Ashcroft	NRG 50m 6"	Campbell Scientific CR510 datalogger	10W PV panel, 12v rechargeable battery	3W Motorolla cell phone	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2m away from tower.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Bald Mountain	NRG 30m 4.5"	Campbell Scientific CR10 datalogger	10W PV panel, 12v rechargeable battery	None	One RM Young WindMonitor at 30m, Sensor mounted on custom heavy duty side-mount boom.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Chilko Lake	NRG 30m 4.5"	Campbell Scientific CR10 datalogger	10W PV panel, 12v rechargeable battery	None	One RM Young WindMonitor at 30m, Sensor mounted on custom heavy duty side-mount boom.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Merritt	NRG 50m 6"	Campbell Scientific CR510 datalogger	10W PV panel, 12v rechargeable battery	3W Motorolla cell phone	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2m away from tower.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Mount Hays	30m free-standing Lattice-style	Campbell Scientific CR10X datalogger	AC power at site, 12v rechargeable battery for backup	3W Motorolla cell phone	One RM Young WindMonitor at 30m, One RM Young WindMonitor at 20m, Sensors mounted on custom side-mount booms.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield.
Bear Mountain	Co-locate on 135m guyed lattice-style	NRG Symphonie Datalogger	AC power at site with internal 12V battery back-up.	Dial-up iPack attached to dedicated land line	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2.5m away from tower.	NRG IceFree II heated anemometer and heated vane at 51m, mounted on heavy-duty NRG booms. NRG #110 temperature probe with solar shield.

continued...

Appendix B: cont'd

	Tower	Datalogger	Power Supply	Communications	Wind Sensors	Other Sensors
Aasen	NRG 50m 6" monitoring tower	Campbell Scientific CR510 datalogger	10W PV panel, 12v rechargeable battery	3W Motorolla cell phone	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2m away from tower.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Bessborough	Co-locate on 50m guyed lattice-style	Campbell Scientific CR510 datalogger	AC power at site, 12v rechargeable battery for backup	Modem attached to dedicated land line	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2.5m away from tower.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 3m.
Erbe	NRG 50m 6" monitoring tower	Campbell Scientific CR510 datalogger	10W PV panel, 12v rechargeable battery	3W Motorolla cell phone	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom heavy duty side-mount booms, extending 2m away from tower.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield at approximately 5m.
Mount Wartenbe	50m NRG 6"	NRG Symphonie datalogger	5W NRG PV panel, 12v rechargable battery in iPack	NRG AMPS iPack (3W cell phone) with 6dBd Yagi antenna	Two NRG Maximum #40 at 50m, one NRG #200P vane at 50m, one NRG Maximum #40 at 30m, one NRG #200P vane at 30m. All sensors mounted on NRG side-mount booms.	NRG #110 Temperature sensor in solar radiation shield.

continued...

Appendix B: cont'd

	Tower	Datalogger	Power Supply	Communications	Wind Sensors	Other Sensors
Alert Bay	50m Western Windpower	Campbell Scientific CR10X datalogger	10W PV panel, 12v rechargable battery	None	One RM Young WindMonitor at 50m, One RM Young WindMonitor at 30m, Sensors mounted on custom side-mount booms.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield.
Pulteney Point	Approximately 2m mast on top of lighthouse	Campbell Scientific CR10X	12v Lighthouse battery bank with large solar array	None, downloaded by lightkeeper	One RM Young WindMonitor mounted on 2m mast above lighthouse.	Campbell Scientific temperature sensor in solar radiation shield, mounted approximately 1.3m above lighthouse.
Port Alice	Co-locate on 30m guyed lattice-style	Campbell Scientific CR10X datalogger	AC power at site, 12v rechargeable battery for backup, switched to PV power on 10 October 2002	3W Motorolla cell phone	One NRG Maximum #40 anemometer and #200P vane at 30m, One NRG Maximum #40 anemometer and #200P vane at 20m, Sensors mounted on NRG heavy duty side-mount booms.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield.
Franklin	50m NRG 6"	NRG Symphonie datalogger	5W NRG PV panel, 12v rechargable battery in iPack	NRG AMPS iPack (3W cell phone) with 6dBd Yagi antenna	Two NRG Maximum #40 at 50m, one NRG #200P vane at 50m, one NRG Maximum #40 at 30m, one NRG #200P vane at 30m. All sensors mounted on NRG side-mount booms.	NRG #110 Temperature sensor in solar radiation shield, NRG #BP20 Barometer, NRG Relative Humidity Sensor.
Great Central Lake	50m NRG 6"	Campbell Scientific CR10X datalogger	10W PV panel, 12v rechargeable battery	3W Motorolla cell phone	One NRG Maximum #40 anemometer and #200P vane at 50m, One NRG Maximum #40 anemometer and #200P vane at 30m, Sensors mounted on NRG side-mount booms.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield.

continued...

Appendix B: Concluded.

	Tower	Datalogger	Power Supply	Communications	Wind Sensors	Other Sensors
Jordan River	30m NRG 4.5"	Campbell Scientific CR10X datalogger	10W PV panel, 12v rechargable battery	None	One RM Young WindMonitor at 30m, One RM Young WindMonitor at 20m, Sensors mounted on custom side-mount booms.	Campbell Scientific 107 Temperature sensor in RM Young solar radiation shield.
Rumble North	50m NRG 6"	Campbell Scientific CR10X Datalogger (initial installation - 04 July 2002) NRG Symphonie datalogger (NRG datalogger install – 23 July 2002)	10W PV panel, 12v rechargable battery (initial installation - 04 July 2002) 5W NRG PV panel, 12v rechargable battery in iPack (NRG datalogger install – 23 July 2002)	None (initial installation - 04 July 2002)RG AMPS iPack (3W cell phone) with 6dBd Yagi antenna (NRG datalogger install – 23 July 2002)	Two NRG Maximum #40 at 50m, one NRG #200P vane at 50m, One NRG Maximum #40 at 30m, one NRG #200P vane at 30m. All sensors mounted on NRG side-mount booms.	None (initial installation - 04 July 2002) NRG #110 Temperature sensor in solar radiation shield, NRG #BP20 Barometer, NRG Relative Humidity Sensor (NRG datalogger install – 23 July 2002).
Rumble	50m NRG 6"	Campbell Scientific CR10X	10W PV panel, 12v rechargable battery	3W Motorolla cell phone	One NRG Maximum #40 at 50m, one NRG #200P vane at 50m, One NRG Maximum #40 at 30m, one NRG #200P vane at 30m. All sensors mounted on NRG side-mount booms.	Campbell Scientific temperature sensor in solar radiation shield.

APPENDIX C

RETScreen Analysis Sheet

North Coast Region

0% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		North Coast	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	7.5	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.2	
Average atmospheric pressure	kPa	97.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.2	
Wind power density at hub height	W/m²	529	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	8,442	42,211	
Pressure adjustment coefficient	-	0.96	0.96	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	8,429	42,143	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,399	1,399	150 to 1,500 kWh/m²
Wind plant capacity factor	%	42%	42%	20% to 40%
Renewable energy delivered	MWh	7,390	**36,948**	
	kWh	7,389,691	36,948,457	
				Complete Cost Analysis sheet

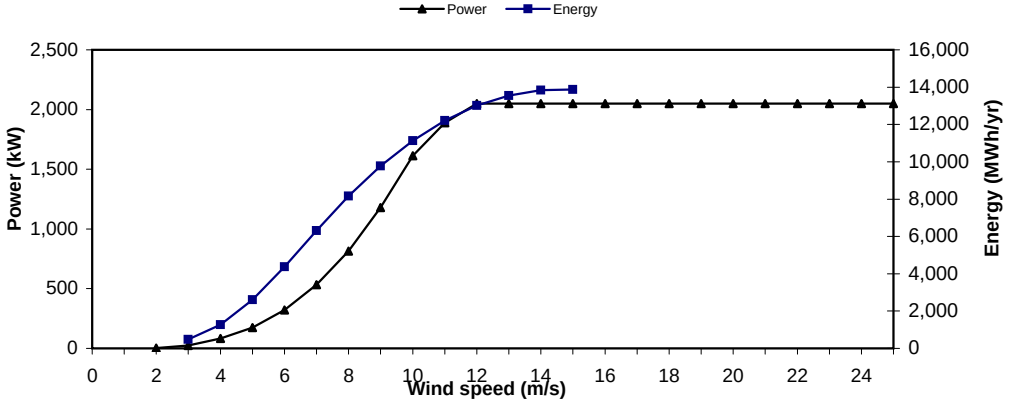
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

North Coast
0% IRR
20 year life of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	36,948,457	CAD	0.003	CAD 92,371		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	181,421	CAD 16,328		-	-
Other - O&M	Cost	1	CAD	557,774	CAD 557,774		-	-
Contingencies	%	4%	CAD	755,523	CAD 30,221		-	-
Annual Costs - Total					**CAD 785,744**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

North Coast
0% IRR
20 year life of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		North Coast			
Renewable energy delivered	MWh	36,948	Net GHG reduction	t_{CO2}/yr	16,693
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	333,854

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0745	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	785,744
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,976,872**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	2,751,552
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	369,485
				Annual Savings - Total	**CAD**	**3,121,036**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.7%			
After-tax IRR and ROI	%	0.7%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	11.4			
Year-to-positive cash flow	yr	19.5	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,016,188)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(589,200)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.25	Debt service coverage	-	0.50

Yearly Cash Flows

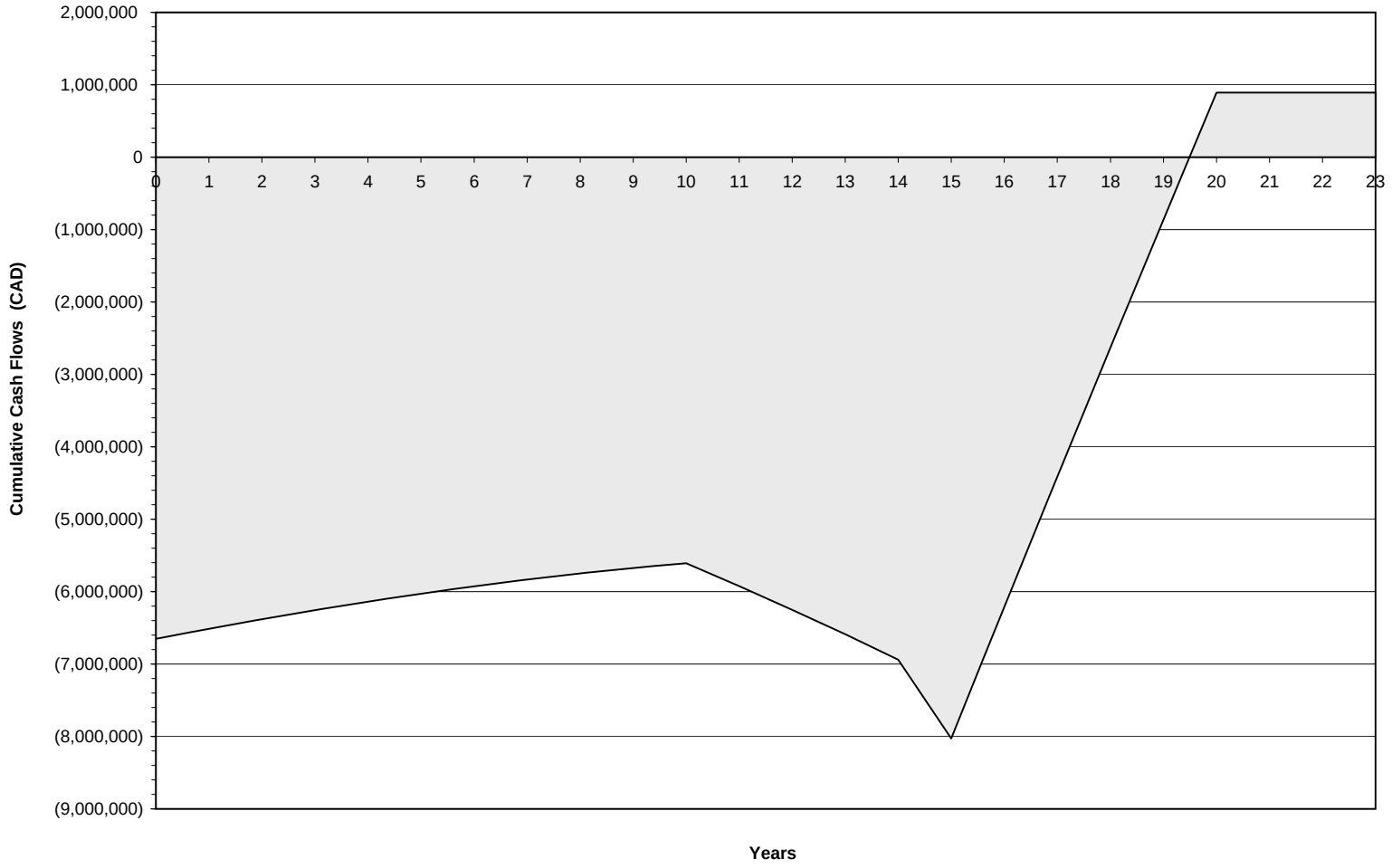
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	138,279	138,279	(6,513,922)
2	131,971	131,971	(6,381,952)
3	125,228	125,228	(6,256,723)
4	118,039	118,039	(6,138,684)
5	110,391	110,391	(6,028,293)
6	102,272	102,272	(5,926,021)
7	93,667	93,667	(5,832,354)
8	84,563	84,563	(5,747,791)
9	74,947	74,947	(5,672,843)
10	64,805	64,805	(5,608,039)
11	(315,364)	(315,364)	(5,923,403)
12	(326,605)	(326,605)	(6,250,008)
13	(338,417)	(338,417)	(6,588,424)
14	(350,816)	(350,816)	(6,939,241)
15	(1,087,969)	(1,087,969)	(8,027,209)
16	1,813,685	1,813,685	(6,213,524)
17	1,799,425	1,799,425	(4,414,100)
18	1,784,510	1,784,510	(2,629,590)
19	1,768,922	1,768,922	(860,668)
20	1,752,644	1,752,644	891,977

North Coast
0% IRR
20 year life of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
North Coast

Renewable energy delivered (MWh/yr): 36,948 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 16,693**



IRR and ROI: 0.7% **Year-to-positive cash flow: 19.5 yr** **Net Present Value: CAD -5,016,188**

North Coast
0% IRR
20 year life of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI	
Perform risk analysis too?	Yes	Sensitivity range	10%	
Project name		Threshold	0.0	%
Project location	North Coast			

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
33,254	-10%	-7.6%	-5.3%	-3.0%	-0.9%	1.2%
35,101	-5%	-5.8%	-3.4%	-1.2%	1.1%	3.2%
36,948	0%	-4.1%	-1.7%	**0.7%**	3.0%	5.3%
38,796	5%	-2.4%	0.1%	2.6%	5.0%	7.4%
40,643	10%	-0.7%	1.9%	4.5%	7.0%	9.5%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-0.9%	1.8%	4.4%	7.0%	9.5%
25,278,364	-5%	-2.6%	0.0%	2.5%	4.9%	7.3%
26,608,804	0%	-4.1%	-1.7%	**0.7%**	3.0%	5.3%
27,939,244	5%	-5.5%	-3.1%	-0.8%	1.4%	3.5%
29,269,684	10%	-6.7%	-4.4%	-2.2%	-0.1%	2.0%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
707,169	-10%	-2.3%	0.0%	2.3%	4.6%	6.8%
746,457	-5%	-3.2%	-0.8%	1.5%	3.8%	6.1%
785,744	0%	-4.1%	-1.7%	**0.7%**	3.0%	5.3%
825,031	5%	-5.0%	-2.5%	-0.1%	2.2%	4.5%
864,318	10%	-6.0%	-3.4%	-1.0%	1.4%	3.7%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	2.6%	2.3%	1.9%	1.6%	1.1%
6.7%	-5%	2.1%	1.7%	1.3%	0.9%	0.4%
7.0%	0%	1.6%	1.2%	**0.7%**	0.2%	-0.4%
7.4%	5%	1.1%	0.6%	0.1%	-0.4%	-1.1%
7.7%	10%	0.6%	0.1%	-0.5%	-1.1%	-1.8%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	3.2%	2.6%	1.9%	2.7%	2.0%
6.7%	-5%	2.8%	2.1%	1.3%	2.1%	1.2%
7.0%	0%	2.3%	1.6%	**0.7%**	1.5%	0.5%
7.4%	5%	1.9%	1.1%	0.1%	0.9%	-0.2%
7.7%	10%	1.4%	0.6%	-0.5%	0.2%	-1.0%

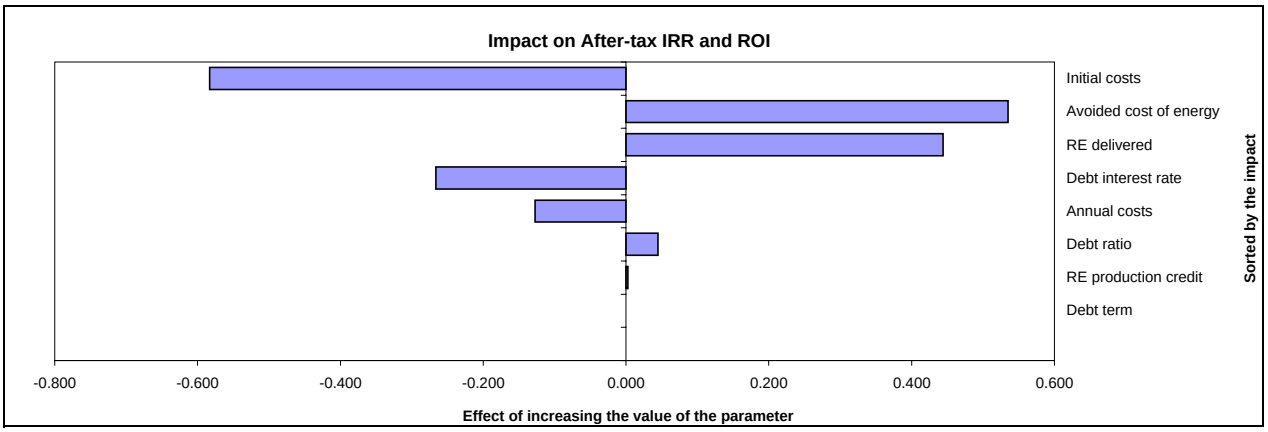
RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
33,254	-10%	-3.3%	-3.2%	-3.0%	-2.9%	-2.8%
35,101	-5%	-1.4%	-1.3%	-1.2%	-1.0%	-0.9%
36,948	0%	0.4%	0.6%	**0.7%**	0.9%	1.0%
38,796	5%	2.3%	2.4%	2.6%	2.8%	3.0%
40,643	10%	4.1%	4.3%	4.5%	4.7%	4.9%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

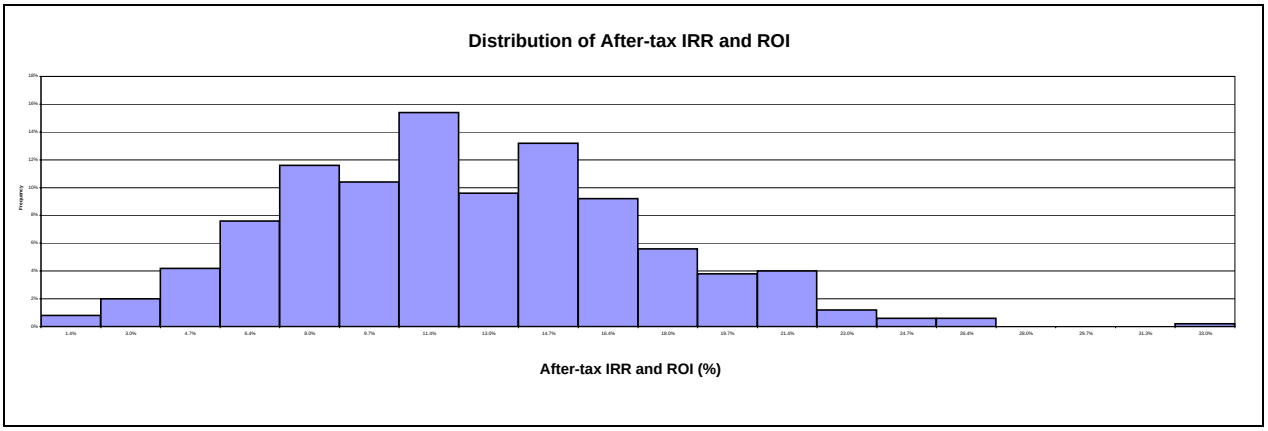
Risk Analysis for After-tax IRR and ROI

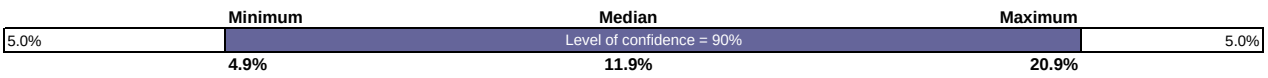
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0745	15%	0.0633	0.0856
RE delivered	MWh	36,948	15%	31,406	42,491
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	785,744	15%	667,882	903,605
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





North Coast
0% IRR
20 year life of project

North Coast Region

0% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		North Coast	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	8.1	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.6	
Average atmospheric pressure	kPa	97.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.8	
Wind power density at hub height	W/m²	666	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	9,500	47,502	
Pressure adjustment coefficient	-	0.96	0.96	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	9,485	47,426	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,575	1,575	150 to 1,500 kWh/m²
Wind plant capacity factor	%	47%	47%	20% to 40%
Renewable energy delivered	MWh	8,316	**41,581**	
	kWh	8,316,130	41,580,652	

Complete Cost Analysis sheet

RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
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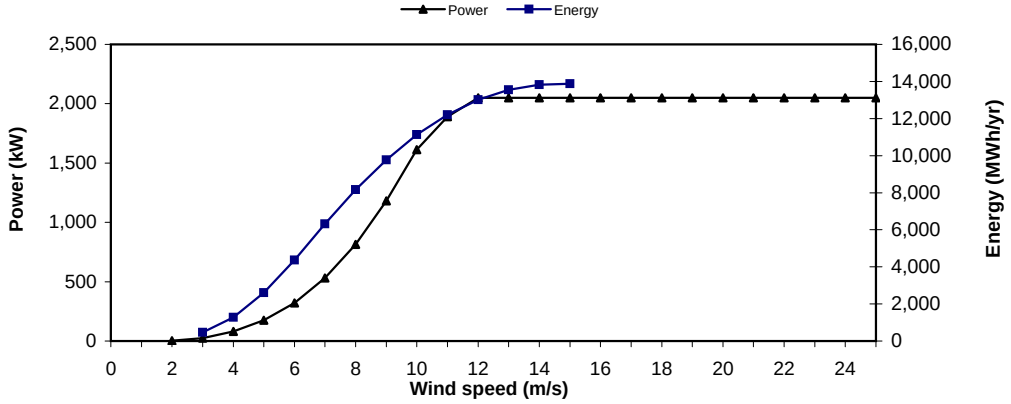
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

North Coast
0% IRR
40 year life of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	41,580,652	CAD	0.003	CAD 103,952		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	193,002	CAD 17,370		-	-
Other - O&M	Cost	1	CAD	627,702	CAD 627,702		-	-
Contingencies	%	4%	CAD	838,073	CAD 33,523		-	-
Annual Costs - Total					**CAD 871,596**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		Go to GHG Analysis sheet

North Coast
0% IRR
40 year life of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		North Coast			
Renewable energy delivered	MWh	41,581	Net GHG reduction	t_{CO2}/yr	18,785
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	751,419

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0745	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	871,596
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,062,724**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,096,511
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	415,807
				Annual Savings - Total	**CAD**	**3,512,318**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.2%			
After-tax IRR and ROI	%	0.2%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	10.1			
Year-to-positive cash flow	yr	16.8	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,638,423)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(576,582)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.15	Debt service coverage	-	1.18

Yearly Cash Flows

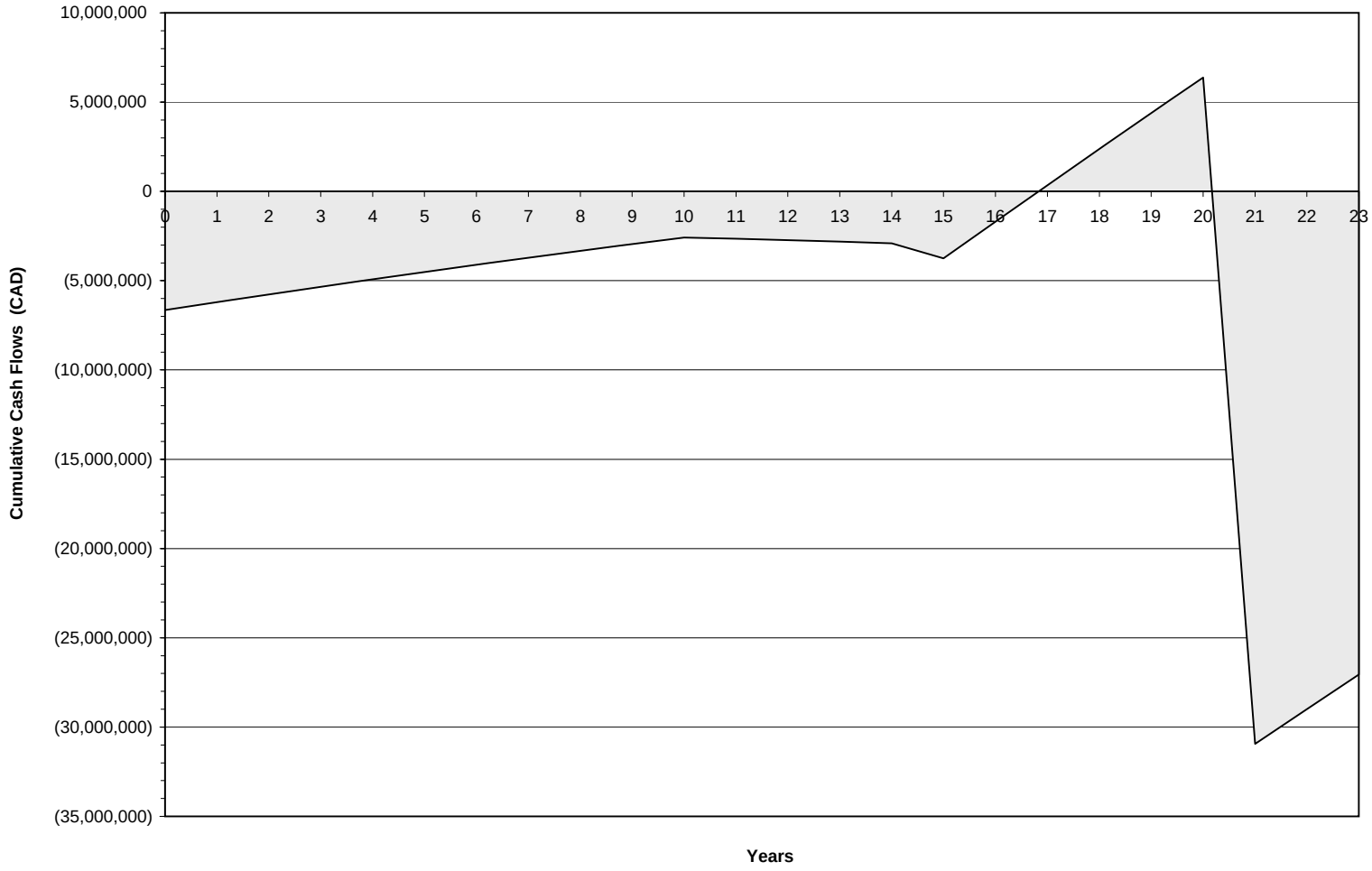
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	443,286	443,286	(6,208,915)
2	436,512	436,512	(5,772,403)
3	429,256	429,256	(5,343,146)
4	421,507	421,507	(4,921,639)
5	413,250	413,250	(4,508,390)
6	404,470	404,470	(4,103,920)
7	395,153	395,153	(3,708,767)
8	385,284	385,284	(3,323,482)
9	374,848	374,848	(2,948,634)
10	363,829	363,829	(2,584,805)
11	(63,596)	(63,596)	(2,648,401)
12	(75,831)	(75,831)	(2,724,231)
13	(88,698)	(88,698)	(2,812,929)
14	(102,216)	(102,216)	(2,915,145)
15	(840,551)	(840,551)	(3,755,697)
16	2,059,852	2,059,852	(1,695,844)
17	2,044,274	2,044,274	348,429
18	2,027,971	2,027,971	2,376,400
19	2,010,923	2,010,923	4,387,322
20	1,993,110	1,993,110	6,380,432
21	(37,327,704)	(37,327,704)	(30,947,272)
22	1,955,105	1,955,105	(28,992,167)
23	1,934,870	1,934,870	(27,057,297)
24	1,913,784	1,913,784	(25,143,513)
25	1,891,823	1,891,823	(23,251,689)
26	1,868,965	1,868,965	(21,382,725)
27	1,845,184	1,845,184	(19,537,541)
28	1,820,456	1,820,456	(17,717,085)
29	1,794,755	1,794,755	(15,922,330)
30	719,273	719,273	(15,203,057)
31	1,740,332	1,740,332	(13,462,725)
32	1,711,555	1,711,555	(11,751,170)
33	1,681,697	1,681,697	(10,069,473)
34	1,650,729	1,650,729	(8,418,744)
35	1,618,622	1,618,622	(6,800,122)
36	1,585,346	1,585,346	(5,214,776)
37	1,550,869	1,550,869	(3,663,907)
38	1,515,159	1,515,159	(2,148,747)
39	1,478,185	1,478,185	(670,562)
40	1,439,911	1,439,911	769,349

North Coast
0% IRR
40 year life of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
North Coast

Renewable energy delivered (MWh/yr): 41,581 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 18,785**



IRR and ROI: 0.2% **Year-to-positive cash flow: 16.8 yr** **Net Present Value: CAD -5,638,423**

North Coast
0% IRR
40 year life of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	North Coast		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
37,423	-10%	-5.3%	-3.8%	-2.3%	-0.7%	1.0%
39,502	-5%	-4.3%	-2.7%	-1.1%	0.7%	2.7%
41,581	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.9%
43,660	5%	-2.4%	-0.5%	1.7%	4.4%	7.7%
45,739	10%	-1.3%	0.9%	3.5%	7.0%	11.1%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-2.8%	-0.7%	1.7%	5.0%	9.6%
25,278,364	-5%	-3.1%	-1.2%	0.9%	3.4%	6.7%
26,608,804	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.9%
27,939,244	5%	-3.7%	-2.0%	-0.3%	1.5%	3.7%
29,269,684	10%	-3.9%	-2.3%	-0.8%	0.9%	2.8%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
784,437	-10%	-1.8%	0.0%	2.0%	4.3%	7.2%
828,016	-5%	-2.6%	-0.8%	1.1%	3.3%	6.0%
871,596	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.9%
915,176	5%	-4.2%	-2.5%	-0.6%	1.4%	3.8%
958,756	10%	-5.1%	-3.3%	-1.5%	0.5%	2.8%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.0%	0.8%	0.7%	0.5%	0.3%
6.7%	-5%	0.8%	0.6%	0.4%	0.3%	0.1%
7.0%	0%	0.6%	0.4%	**0.2%**	0.0%	-0.1%
7.4%	5%	0.4%	0.2%	0.0%	-0.2%	-0.4%
7.7%	10%	0.2%	0.0%	-0.2%	-0.4%	-0.6%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.4%	1.0%	0.7%	1.0%	0.6%
6.7%	-5%	1.2%	0.8%	0.4%	0.7%	0.4%
7.0%	0%	1.0%	0.6%	**0.2%**	0.5%	0.1%
7.4%	5%	0.8%	0.4%	0.0%	0.3%	-0.1%
7.7%	10%	0.6%	0.2%	-0.2%	0.1%	-0.3%

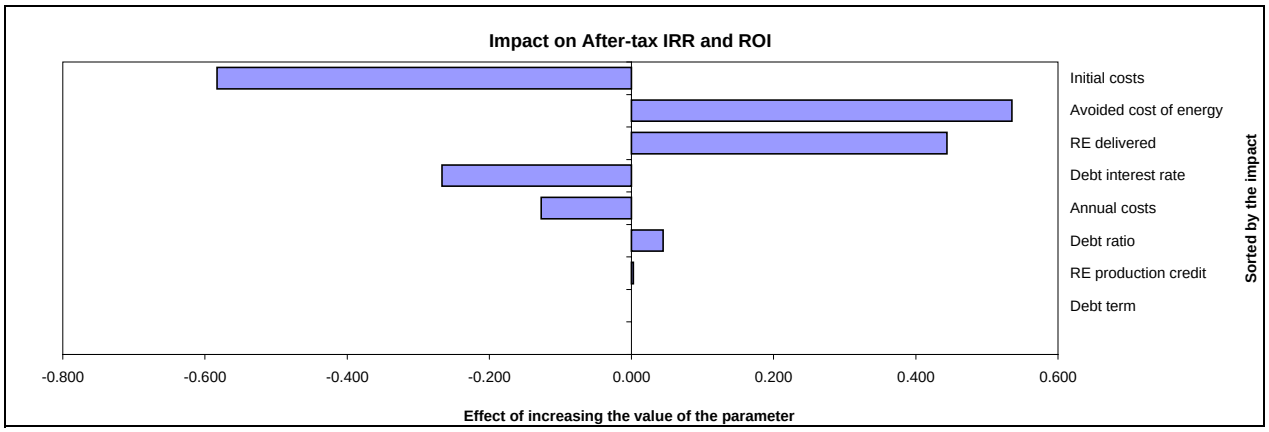
RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
37,423	-10%	-2.3%	-2.3%	-2.3%	-2.2%	-2.2%
39,502	-5%	-1.2%	-1.1%	-1.1%	-1.0%	-1.0%
41,581	0%	0.1%	0.2%	**0.2%**	0.3%	0.3%
43,660	5%	1.5%	1.6%	1.7%	1.8%	1.9%
45,739	10%	3.3%	3.4%	3.5%	3.7%	3.8%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

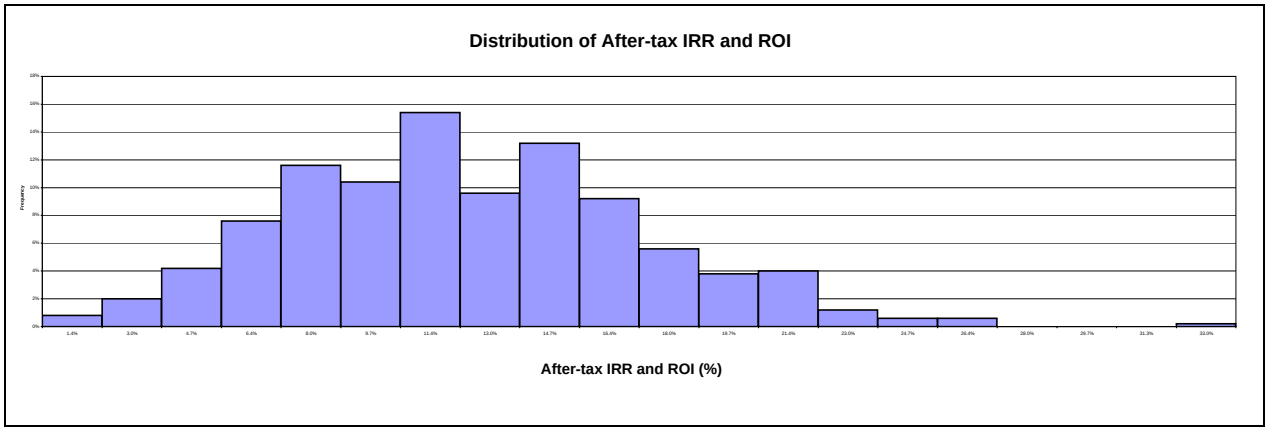
Risk Analysis for After-tax IRR and ROI

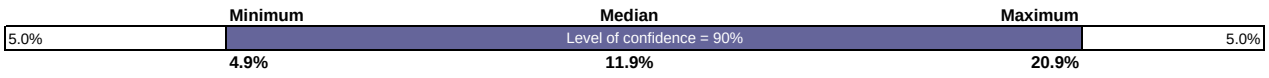
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0745	15%	0.0633	0.0856
RE delivered	MWh	41,581	15%	35,344	47,818
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	871,596	15%	740,857	1,002,336
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





North Coast
0% IRR
40 year life of project

North Coast Region

8% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		North Coast	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	8.5	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.8	
Average atmospheric pressure	kPa	97.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	9.3	
Wind power density at hub height	W/m²	770	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	10,135	50,675	
Pressure adjustment coefficient	-	0.96	0.96	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	10,119	50,594	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,680	1,680	150 to 1,500 kWh/m²
Wind plant capacity factor	%	51%	51%	20% to 40%
Renewable energy delivered	MWh	8,872	**44,358**	
	kWh	8,871,509	44,357,546	
				Complete Cost Analysis sheet

North Coast
8% IRR
20 year life of project

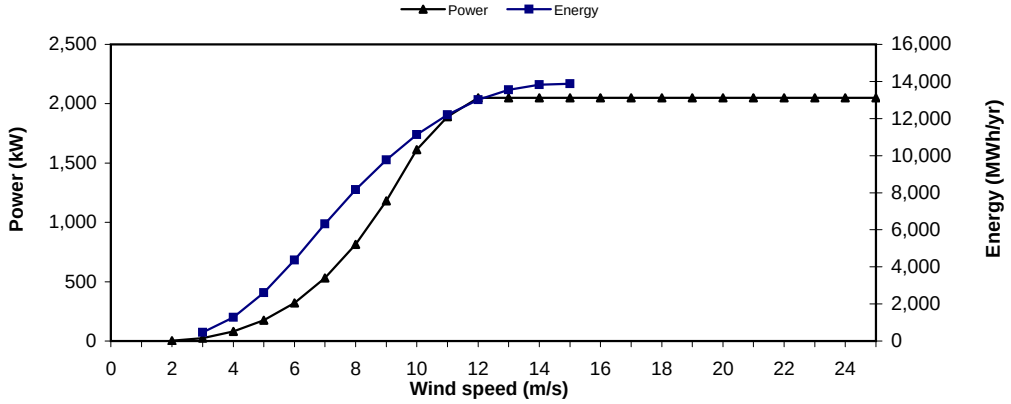
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

North Coast
8% IRR
20 year life of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	44,357,546	CAD	0.003	CAD 110,894		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	199,944	CAD 17,995		-	-
Other - O&M	Cost	1	CAD	669,622	CAD 669,622		-	-
Contingencies	%	4%	CAD	887,560	CAD 35,502		-	-
Annual Costs - Total					**CAD 923,063**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

North Coast
8% IRR
20 year life of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		North Coast			
Renewable energy delivered	MWh	44,358	Net GHG reduction	t_{CO2}/yr	20,040
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	400,801

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0745	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	923,063
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,114,190**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,303,306
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	443,575
				Annual Savings - Total	**CAD**	**3,746,882**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	7.9%			
After-tax IRR and ROI	%	7.9%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	9.4			
Year-to-positive cash flow	yr	15.5	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(1,102,173)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(129,461)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.83	Debt service coverage	-	1.28

Yearly Cash Flows

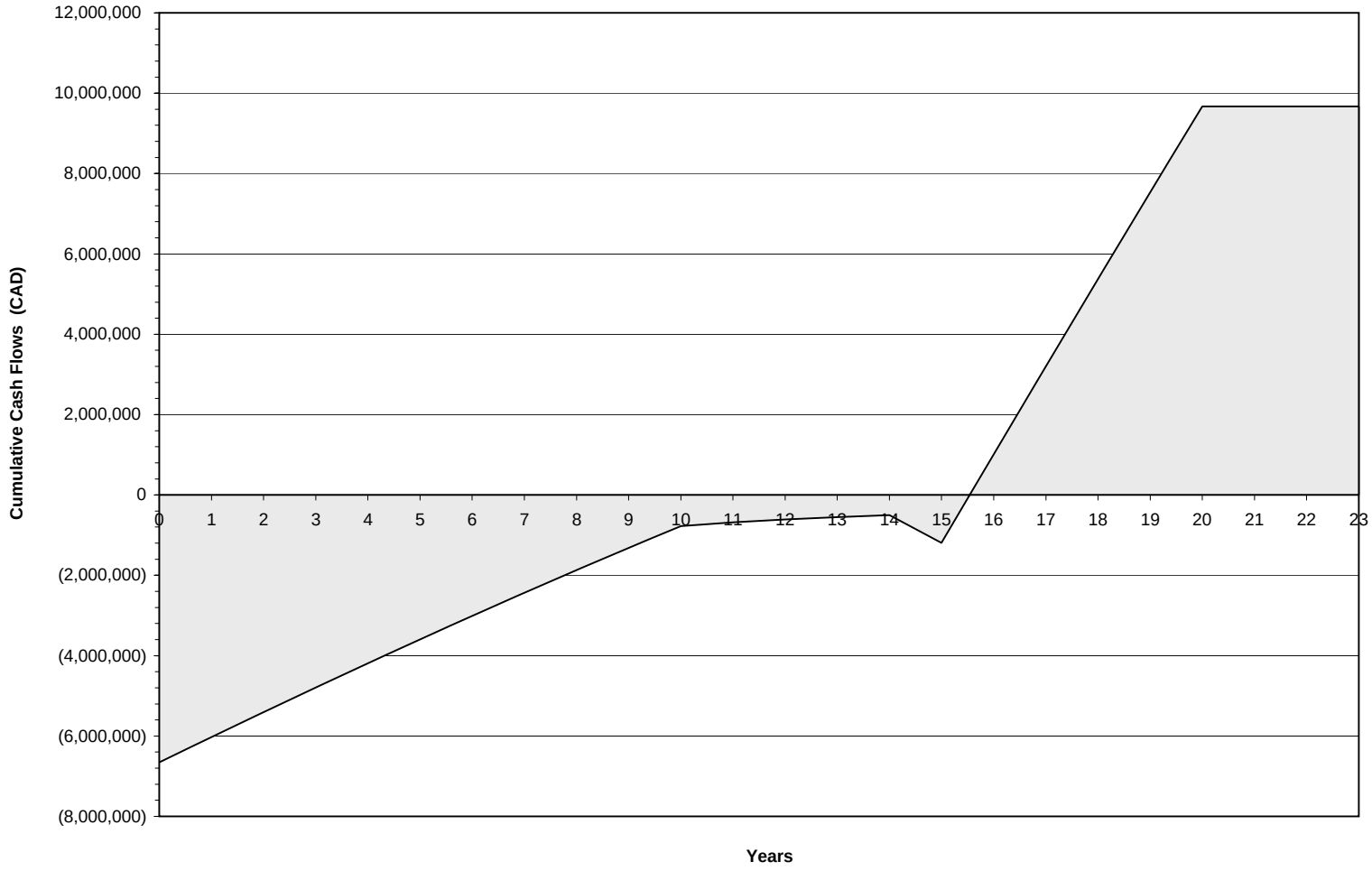
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	626,131	626,131	(6,026,070)
2	619,077	619,077	(5,406,992)
3	611,514	611,514	(4,795,478)
4	603,429	603,429	(4,192,049)
5	594,806	594,806	(3,597,243)
6	585,631	585,631	(3,011,613)
7	575,887	575,887	(2,435,725)
8	565,560	565,560	(1,870,166)
9	554,632	554,632	(1,315,534)
10	543,087	543,087	(772,446)
11	87,333	87,333	(685,113)
12	74,503	74,503	(610,611)
13	61,002	61,002	(549,608)
14	46,814	46,814	(502,794)
15	(692,231)	(692,231)	(1,195,025)
16	2,207,424	2,207,424	1,012,400
17	2,191,055	2,191,055	3,203,455
18	2,173,920	2,173,920	5,377,375
19	2,155,996	2,155,996	7,533,371
20	2,137,263	2,137,263	9,670,634

North Coast
8% IRR
20 year life of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
North Coast

Renewable energy delivered (MWh/yr): 44,358 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 20,040**



IRR and ROI: 7.9% **Year-to-positive cash flow: 15.5 yr** **Net Present Value: CAD -1,102,173**

North Coast
8% IRR
20 year life of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI	
Perform risk analysis too?	Yes	Sensitivity range	10%	
Project name		Threshold	0.0	%
Project location	North Coast			

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
39,922	-10%	-1.8%	0.8%	3.3%	5.8%	8.3%
42,140	-5%	0.2%	3.0%	5.6%	8.2%	10.8%
44,358	0%	2.3%	5.1%	**7.9%**	10.7%	13.4%
46,575	5%	4.4%	7.3%	10.3%	13.1%	15.9%
48,793	10%	6.4%	9.6%	12.6%	15.6%	18.5%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
23,947,923	-10%	6.3%	9.5%	12.6%	15.6%	18.6%
25,278,364	-5%	4.2%	7.2%	10.1%	13.0%	15.8%
26,608,804	0%	2.3%	5.1%	**7.9%**	10.7%	13.4%
27,939,244	5%	0.6%	3.3%	6.0%	8.6%	11.1%
29,269,684	10%	-0.9%	1.7%	4.2%	6.7%	9.1%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
830,756	-10%	4.2%	7.0%	9.7%	12.4%	15.1%
876,910	-5%	3.3%	6.1%	8.8%	11.5%	14.2%
923,063	0%	2.3%	5.1%	**7.9%**	10.7%	13.4%
969,216	5%	1.3%	4.2%	7.0%	9.8%	12.5%
1,015,369	10%	0.3%	3.2%	6.1%	8.9%	11.6%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	8.8%	9.0%	9.3%	9.6%	10.1%
6.7%	-5%	8.3%	8.4%	8.6%	8.8%	9.1%
7.0%	0%	7.8%	7.8%	**7.9%**	8.0%	8.2%
7.4%	5%	7.3%	7.3%	7.3%	7.2%	7.2%
7.7%	10%	6.8%	6.7%	6.6%	6.5%	6.3%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.4%	9.3%	9.3%	10.2%	10.2%
6.7%	-5%	8.9%	8.7%	8.6%	9.5%	9.4%
7.0%	0%	8.4%	8.1%	**7.9%**	8.8%	8.6%
7.4%	5%	7.9%	7.6%	7.3%	8.1%	7.8%
7.7%	10%	7.3%	7.0%	6.6%	7.4%	7.0%

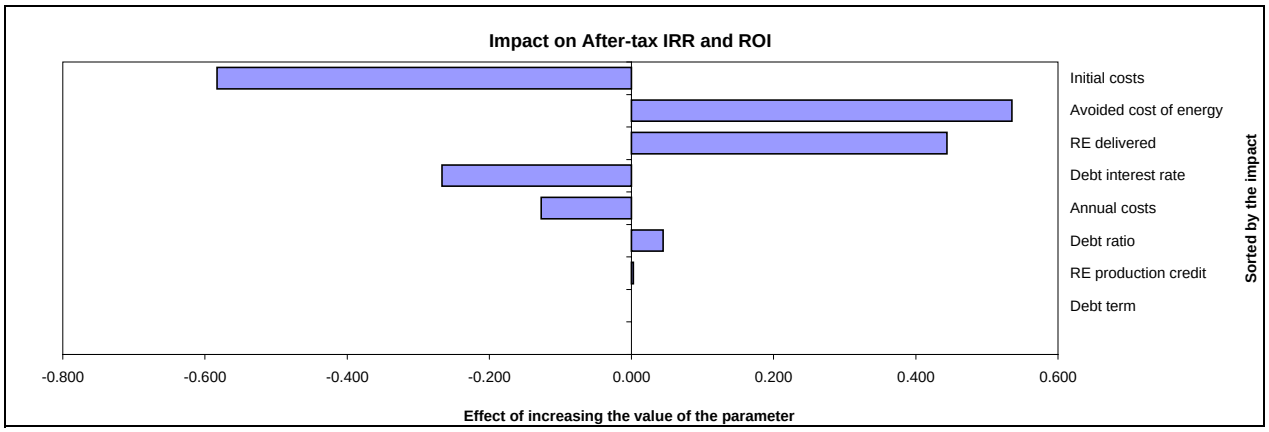
RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
39,922	-10%	3.0%	3.1%	3.3%	3.5%	3.7%
42,140	-5%	5.2%	5.4%	5.6%	5.8%	6.1%
44,358	0%	7.5%	7.7%	**7.9%**	8.2%	8.4%
46,575	5%	9.7%	10.0%	10.3%	10.5%	10.8%
48,793	10%	12.0%	12.3%	12.6%	12.9%	13.2%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

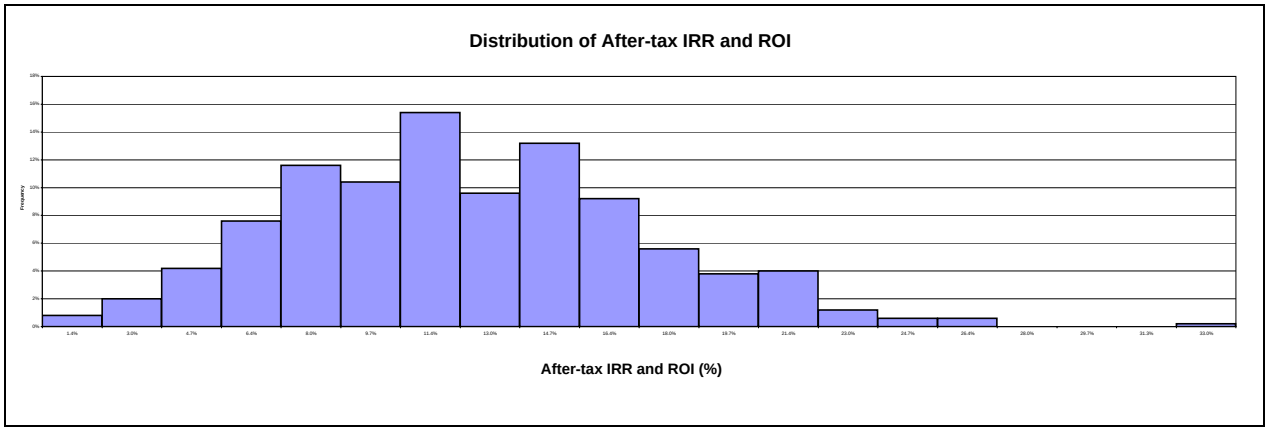
Risk Analysis for After-tax IRR and ROI

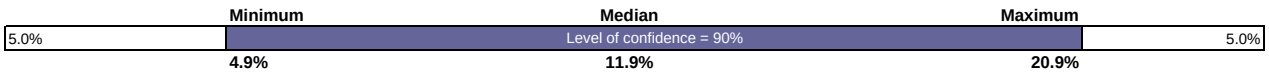
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0745	15%	0.0633	0.0856
RE delivered	MWh	44,358	15%	37,704	51,011
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	923,063	15%	784,603	1,061,522
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





North Coast
8% IRR
20 year life of project

North Coast Region

8% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		North Coast	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	9.4	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	6.5	
Average atmospheric pressure	kPa	97.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	2000	→	Complete Equipment Data sheet
Number of turbines	-	5		
Wind plant capacity	kW	10,000		
Hub height	m	100.0		6.0 to 100.0 m
Wind speed at hub height	m/s	10.2		
Wind power density at hub height	W/m²	1,041		
Array losses	%	5%		0% to 20%
Airfoil soiling and/or icing losses	%	2%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	4%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	11,393	56,963	
Pressure adjustment coefficient	-	0.96	0.96	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	11,374	56,872	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,888	1,888	150 to 1,500 kWh/m²
Wind plant capacity factor	%	57%	57%	20% to 40%
Renewable energy delivered	MWh	9,972	**49,862**	
	kWh	9,972,333	49,861,665	
				Complete Cost Analysis sheet

North Coast
8% IRR
40 year lifetime of project

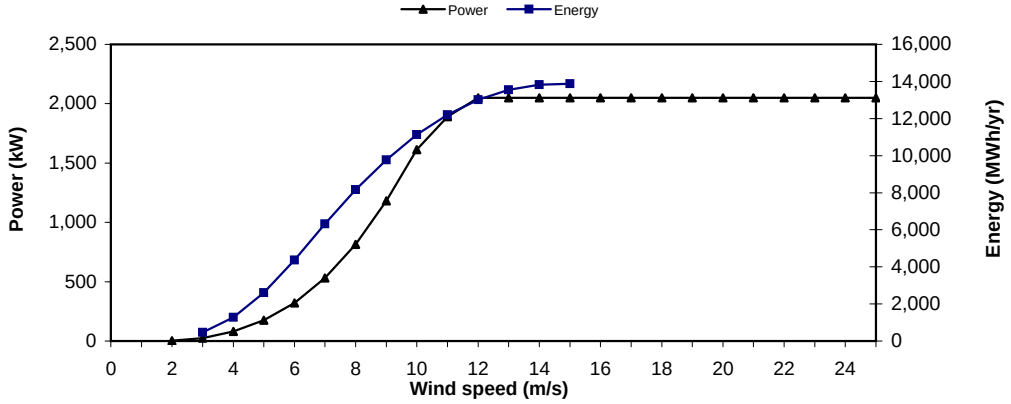
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

North Coast
8% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	49,861,665	CAD	0.003	CAD 124,654		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	213,704	CAD 19,233		-	-
Other - O&M	Cost	1	CAD	752,712	CAD 752,712		-	-
Contingencies	%	4%	CAD	985,649	CAD 39,426		-	-
Annual Costs - Total					**CAD 1,025,075**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		Go to GHG Analysis sheet

North Coast
8% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		North Coast			
Renewable energy delivered	MWh	49,862	Net GHG reduction	t_{CO2}/yr	22,527
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	901,068

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0745	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	1,025,075
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,216,203**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,713,198
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	498,617
				Annual Savings - Total	**CAD**	**4,211,815**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	8.0%			
After-tax IRR and ROI	%	8.0%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8.3			
Year-to-positive cash flow	yr	6.9	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(754,769)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(77,182)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.89	Debt service coverage	-	1.44

Yearly Cash Flows

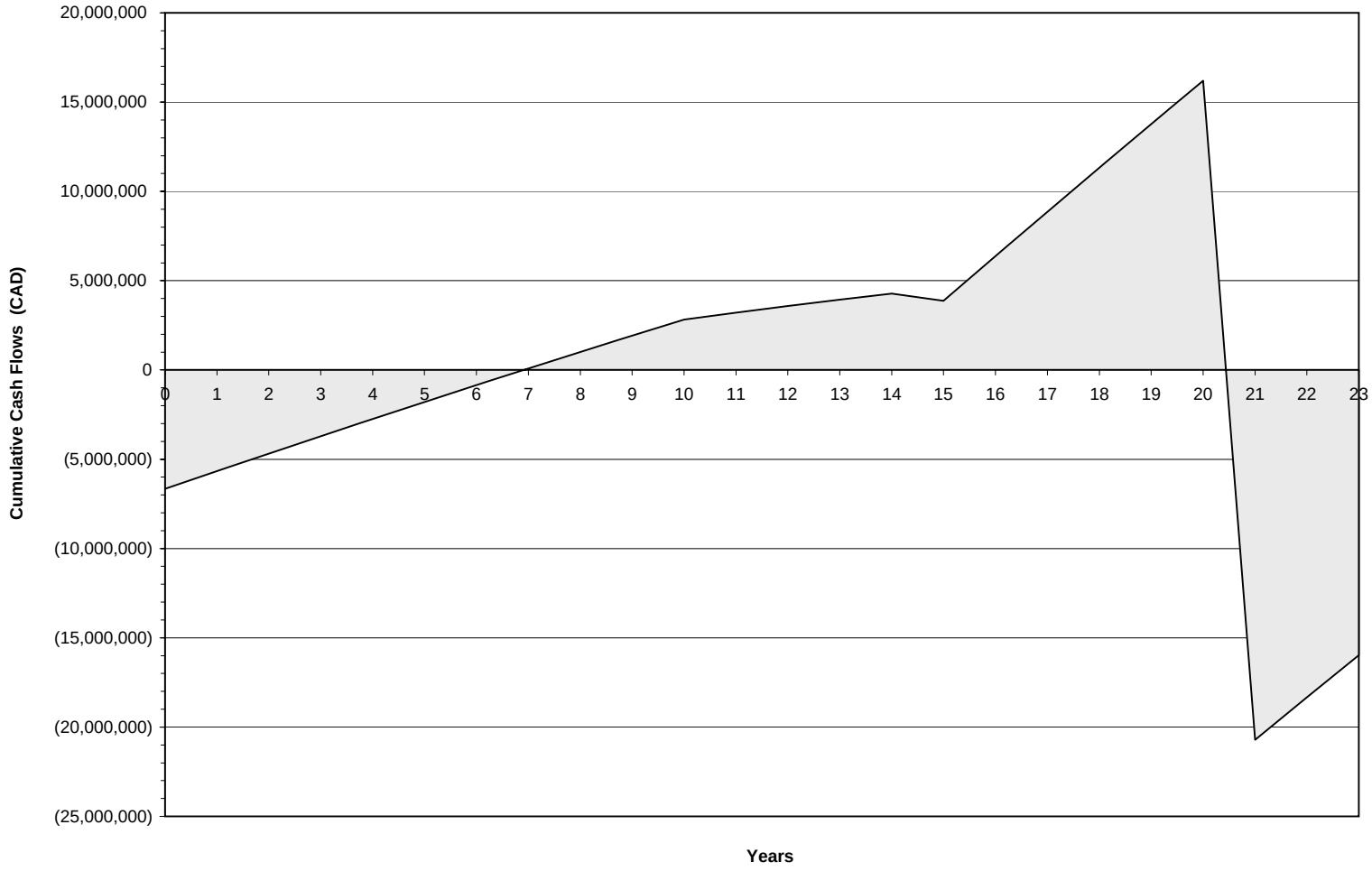
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	988,551	988,551	(5,663,650)
2	980,942	980,942	(4,682,708)
3	972,770	972,770	(3,709,937)
4	964,019	964,019	(2,745,919)
5	954,672	954,672	(1,791,247)
6	944,712	944,712	(846,535)
7	934,123	934,123	87,587
8	922,886	922,886	1,010,473
9	910,984	910,984	1,921,457
10	898,398	898,398	2,819,855
11	386,492	386,492	3,206,347
12	372,480	372,480	3,578,827
13	357,726	357,726	3,936,553
14	342,209	342,209	4,278,762
15	(398,242)	(398,242)	3,880,520
16	2,499,928	2,499,928	6,380,448
17	2,481,993	2,481,993	8,862,441
18	2,463,208	2,463,208	11,325,649
19	2,443,548	2,443,548	13,769,197
20	2,422,991	2,422,991	16,192,188
21	(36,900,703)	(36,900,703)	(20,708,515)
22	2,379,086	2,379,086	(18,329,430)
23	2,355,686	2,355,686	(15,973,743)
24	2,331,288	2,331,288	(13,642,456)
25	2,305,862	2,305,862	(11,336,593)
26	2,279,383	2,279,383	(9,057,210)
27	2,251,821	2,251,821	(6,805,389)
28	2,223,147	2,223,147	(4,582,242)
29	2,193,332	2,193,332	(2,388,910)
30	1,113,560	1,113,560	(1,275,349)
31	2,130,153	2,130,153	854,803
32	2,096,725	2,096,725	2,951,528
33	2,062,028	2,062,028	5,013,557
34	2,026,029	2,026,029	7,039,585
35	1,988,691	1,988,691	9,028,276
36	1,949,980	1,949,980	10,978,257
37	1,909,860	1,909,860	12,888,116
38	1,868,292	1,868,292	14,756,408
39	1,825,238	1,825,238	16,581,645
40	1,780,659	1,780,659	18,362,304

North Coast
8% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
North Coast

Renewable energy delivered (MWh/yr): 49,862 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 22,527**



IRR and ROI: 8% **Year-to-positive cash flow: 6.9 yr** **Net Present Value: CAD -754,769**

North Coast
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	North Coast		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
44,875	-10%	-2.3%	-0.2%	2.2%	5.1%	8.9%
47,369	-5%	-0.9%	1.5%	4.6%	8.7%	13.2%
49,862	0%	0.6%	3.7%	**8.0%**	13.0%	17.3%
52,355	5%	2.5%	6.8%	12.2%	16.9%	21.0%
54,848	10%	5.0%	10.8%	16.1%	20.5%	24.4%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
23,947,923	-10%	2.6%	8.7%	15.4%	20.3%	24.4%
25,278,364	-5%	1.4%	5.5%	11.3%	16.5%	20.7%
26,608,804	0%	0.6%	3.7%	**8.0%**	13.0%	17.3%
27,939,244	5%	0.0%	2.6%	5.9%	10.0%	14.2%
29,269,684	10%	-0.5%	1.7%	4.4%	7.7%	11.4%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0670	0.0707	**0.0745**	0.0782	0.0819
		-10%	-5%	0%	5%	10%
922,568	-10%	3.0%	6.8%	11.4%	15.8%	19.7%
973,821	-5%	1.8%	5.2%	9.8%	14.5%	18.5%
1,025,075	0%	0.6%	3.7%	**8.0%**	13.0%	17.3%
1,076,329	5%	-0.5%	2.4%	6.3%	11.3%	16.0%
1,127,583	10%	-1.7%	1.1%	4.6%	9.6%	14.5%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.1%	9.5%	9.9%	10.6%	11.7%
6.7%	-5%	8.5%	8.7%	8.9%	9.3%	9.9%
7.0%	0%	7.8%	7.9%	**8.0%**	8.2%	8.4%
7.4%	5%	7.2%	7.2%	7.2%	7.2%	7.2%
7.7%	10%	6.7%	6.6%	6.5%	6.4%	6.2%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	10.0%	9.9%	9.9%	11.3%	11.4%
6.7%	-5%	9.3%	9.1%	8.9%	10.2%	10.1%
7.0%	0%	8.6%	8.3%	**8.0%**	9.2%	9.0%
7.4%	5%	7.9%	7.6%	7.2%	8.2%	7.9%
7.7%	10%	7.3%	6.9%	6.5%	7.4%	6.9%

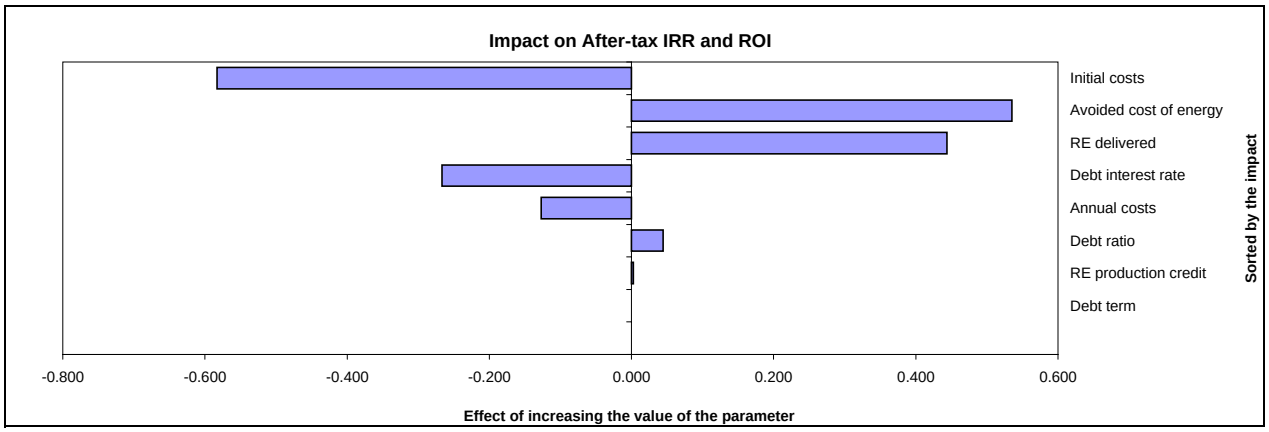
RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
44,875	-10%	2.0%	2.1%	2.2%	2.3%	2.4%
47,369	-5%	4.3%	4.5%	4.6%	4.8%	5.1%
49,862	0%	7.4%	7.7%	**8.0%**	8.4%	8.8%
52,355	5%	11.3%	11.7%	12.2%	12.6%	13.1%
54,848	10%	15.2%	15.6%	16.1%	16.6%	17.1%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

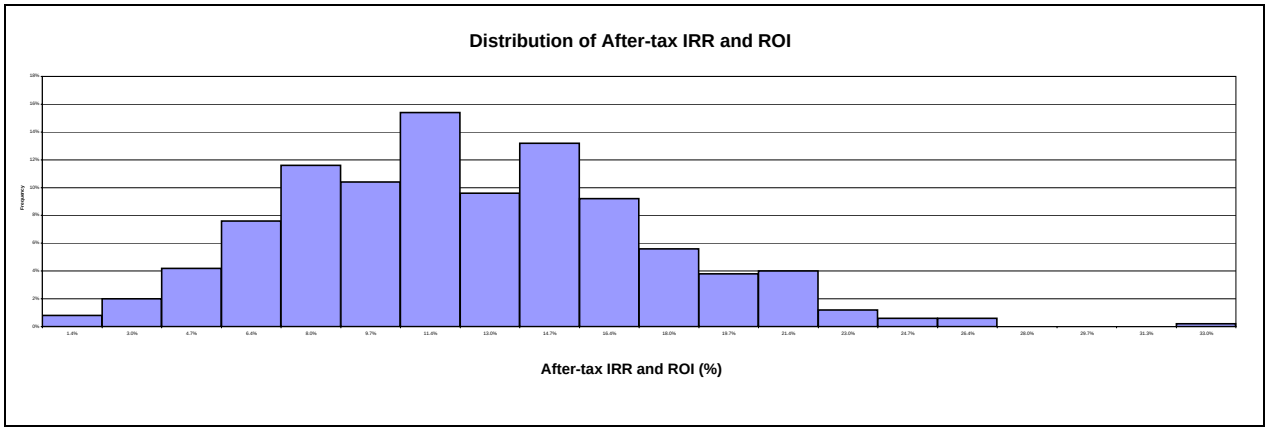
Risk Analysis for After-tax IRR and ROI

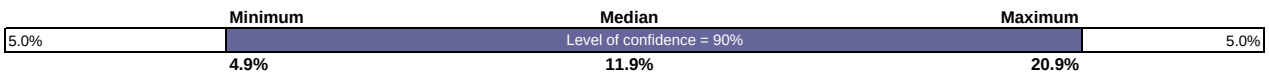
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0745	15%	0.0633	0.0856
RE delivered	MWh	49,862	15%	42,382	57,341
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	1,025,075	15%	871,314	1,178,836
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





North Coast
8% IRR
40 year lifetime of project

Peace Region

0% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Peace Region	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	7.8	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.4	
Average atmospheric pressure	kPa	91.0	60.0 to 103.0 kPa
Annual average temperature	°C	1	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.5	
Wind power density at hub height	W/m²	595	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	8,971	44,857	
Pressure adjustment coefficient	-	0.90	0.90	0.59 to 1.02
Temperature adjustment coefficient	-	1.05	1.05	0.98 to 1.15
Gross energy production	MWh	8,478	42,389	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,407	1,407	150 to 1,500 kWh/m²
Wind plant capacity factor	%	42%	42%	20% to 40%
Renewable energy delivered	MWh	7,433	**37,164**	
	kWh	7,432,893	37,164,467	

Complete Cost Analysis sheet

Peace Region
0% IRR
20 year lifetime of project

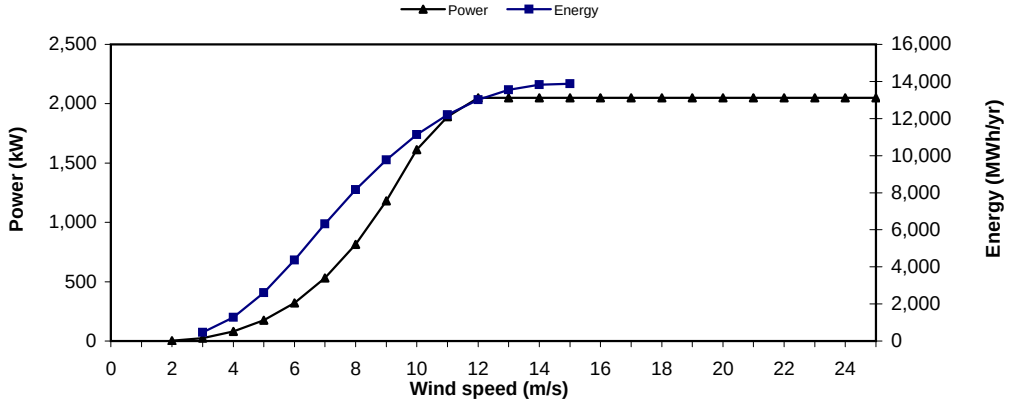
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Peace Region
0% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	37,164,467	CAD	0.003	CAD 92,911		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	181,961	CAD 16,377		-	-
Other - O&M	Cost	1	CAD	561,035	CAD 561,035		-	-
Contingencies	%	4%	CAD	759,372	CAD 30,375		-	-
Annual Costs - Total					**CAD 789,747**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		Go to GHG Analysis sheet

Peace Region
0% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Peace Region			
Renewable energy delivered	MWh	37,164	Net GHG reduction	t_{CO2}/yr	16,790
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	335,806

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0730	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	789,747
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,980,875**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	2,714,493
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	371,645
				Annual Savings - Total	**CAD**	**3,086,137**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.0%			
After-tax IRR and ROI	%	0.0%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	11.6			
Year-to-positive cash flow	yr	20.0	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,371,959)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(630,988)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.19	Debt service coverage	-	0.48

Yearly Cash Flows

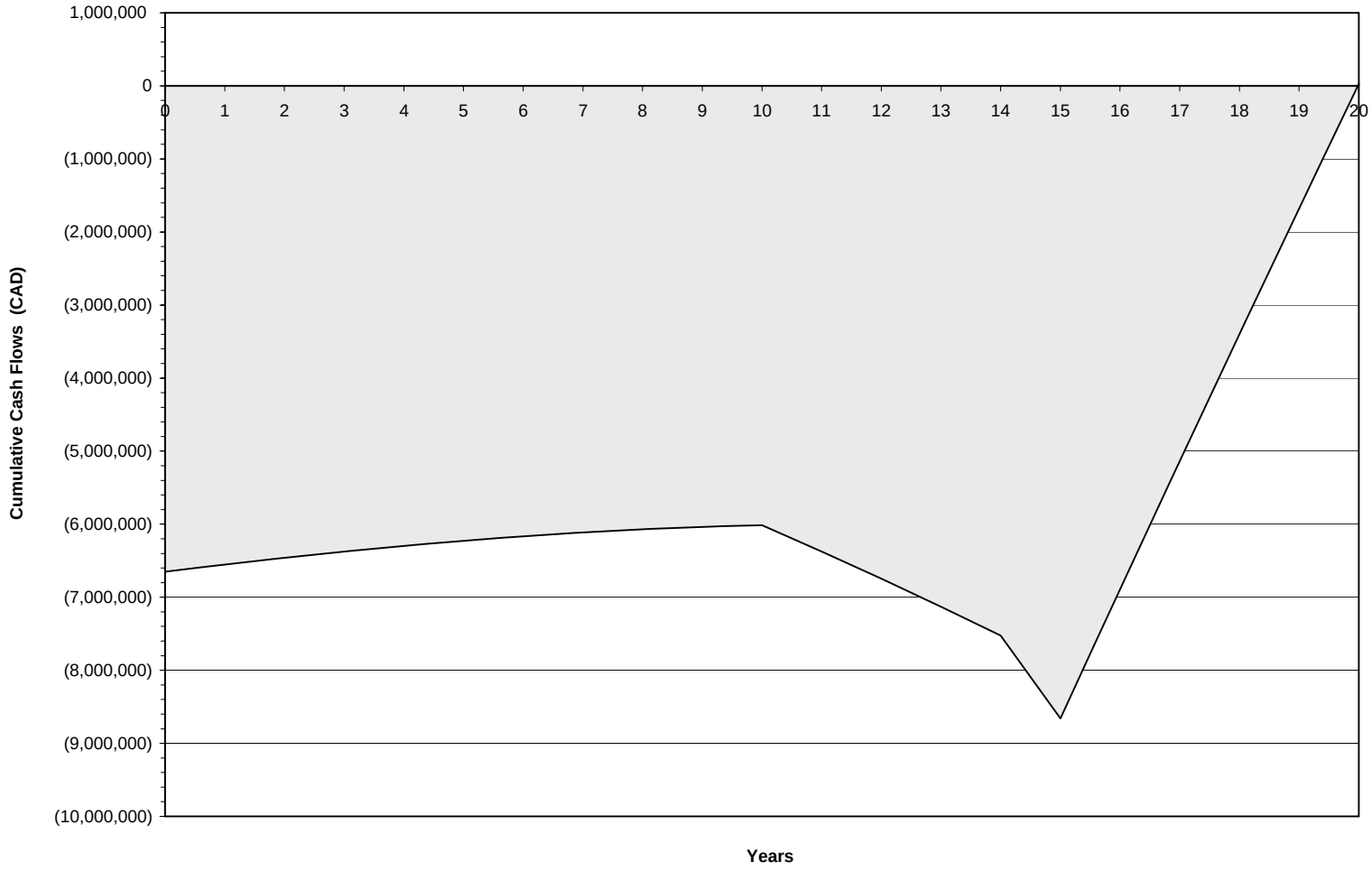
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	99,091	99,091	(6,553,110)
2	92,494	92,494	(6,460,616)
3	85,459	85,459	(6,375,156)
4	77,975	77,975	(6,297,182)
5	70,027	70,027	(6,227,154)
6	61,604	61,604	(6,165,550)
7	52,692	52,692	(6,112,858)
8	43,278	43,278	(6,069,579)
9	33,347	33,347	(6,036,232)
10	22,886	22,886	(6,013,346)
11	(359,766)	(359,766)	(6,373,112)
12	(371,333)	(371,333)	(6,744,446)
13	(383,477)	(383,477)	(7,127,923)
14	(396,212)	(396,212)	(7,524,135)
15	(1,133,705)	(1,133,705)	(8,657,840)
16	1,767,604	1,767,604	(6,890,235)
17	1,752,995	1,752,995	(5,137,241)
18	1,737,726	1,737,726	(3,399,515)
19	1,721,780	1,721,780	(1,677,735)
20	1,705,138	1,705,138	27,403

Peace Region
0% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Peace Region

Renewable energy delivered (MWh/yr): 37,164 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 16,790**



IRR and ROI: 0% **Year-to-positive cash flow: 20 yr** **Net Present Value: CAD -5,371,959**

Peace Region
0% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI	
Perform risk analysis too?	Yes	Sensitivity range	10%	
Project name		Threshold	0.0	%
Project location	Peace Region			

Sensitivity Analysis for After-tax IRR and ROI

Avoided cost of energy (CAD/kWh)

RE delivered (MWh)		0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
33,448	-10%	-6.2%	-4.6%	-3.0%	-1.5%	0.0%
35,306	-5%	-5.0%	-3.3%	-1.7%	-0.1%	1.4%
37,164	0%	-3.8%	-2.1%	**-0.4%**	1.2%	2.9%
39,023	5%	-2.7%	-0.9%	0.9%	2.6%	4.3%
40,881	10%	-1.5%	0.4%	2.2%	4.0%	5.8%

Avoided cost of energy (CAD/kWh)

Initial costs (CAD)		0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
23,947,923	-10%	-1.7%	0.2%	2.1%	3.9%	5.7%
25,278,364	-5%	-2.8%	-1.0%	0.8%	2.5%	4.2%
26,608,804	0%	-3.8%	-2.1%	**-0.4%**	1.2%	2.9%
27,939,244	5%	-4.7%	-3.1%	-1.4%	0.1%	1.7%
29,269,684	10%	-5.6%	-3.9%	-2.4%	-0.9%	0.6%

Avoided cost of energy (CAD/kWh)

Annual costs (CAD)		0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
710,773	-10%	-2.5%	-0.8%	0.8%	2.5%	4.0%
750,260	-5%	-3.1%	-1.4%	0.2%	1.9%	3.5%
789,747	0%	-3.8%	-2.1%	**-0.4%**	1.2%	2.9%
829,235	5%	-4.5%	-2.8%	-1.0%	0.6%	2.3%
868,722	10%	-5.3%	-3.4%	-1.7%	0.0%	1.7%

Debt ratio (%)

Debt interest rate (%)		67.5% -10%	71.3% -5%	**75.0% 0%**	78.8% 5%	82.5% 10%
6.3%	-10%	1.0%	0.7%	0.4%	0.1%	-0.3%
6.7%	-5%	0.7%	0.3%	0.0%	-0.4%	-0.7%
7.0%	0%	0.3%	0.0%	**-0.4%**	-0.8%	-1.2%
7.4%	5%	0.0%	-0.4%	-0.8%	-1.2%	-1.7%
7.7%	10%	-0.4%	-0.8%	-1.2%	-1.6%	-2.1%

Debt term (yr)

Debt interest rate (%)		13.5 -10%	14.3 -5%	**15.0 0%**	15.8 5%	16.5 10%
6.3%	-10%	1.6%	1.0%	0.4%	1.0%	0.3%
6.7%	-5%	1.3%	0.7%	0.0%	0.5%	-0.2%
7.0%	0%	0.9%	0.3%	**-0.4%**	0.1%	-0.7%
7.4%	5%	0.6%	-0.1%	-0.8%	-0.3%	-1.1%
7.7%	10%	0.3%	-0.4%	-1.2%	-0.7%	-1.6%

RE production credit (CAD/kWh)

RE delivered (MWh)		0.009 -10%	0.010 -5%	**0.010 0%**	0.011 5%	0.011 10%
33,448	-10%	-3.1%	-3.1%	-3.0%	-2.9%	-2.9%
35,306	-5%	-1.9%	-1.8%	-1.7%	-1.6%	-1.5%
37,164	0%	-0.6%	-0.5%	**-0.4%**	-0.3%	-0.2%
39,023	5%	0.7%	0.8%	0.9%	1.0%	1.1%
40,881	10%	2.0%	2.1%	2.2%	2.3%	2.4%

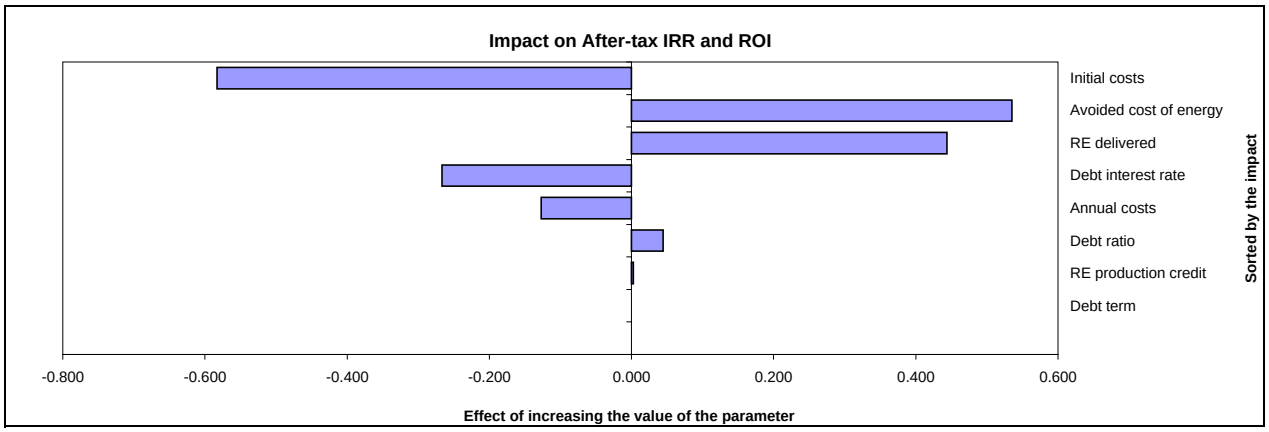
Peace Region
0% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

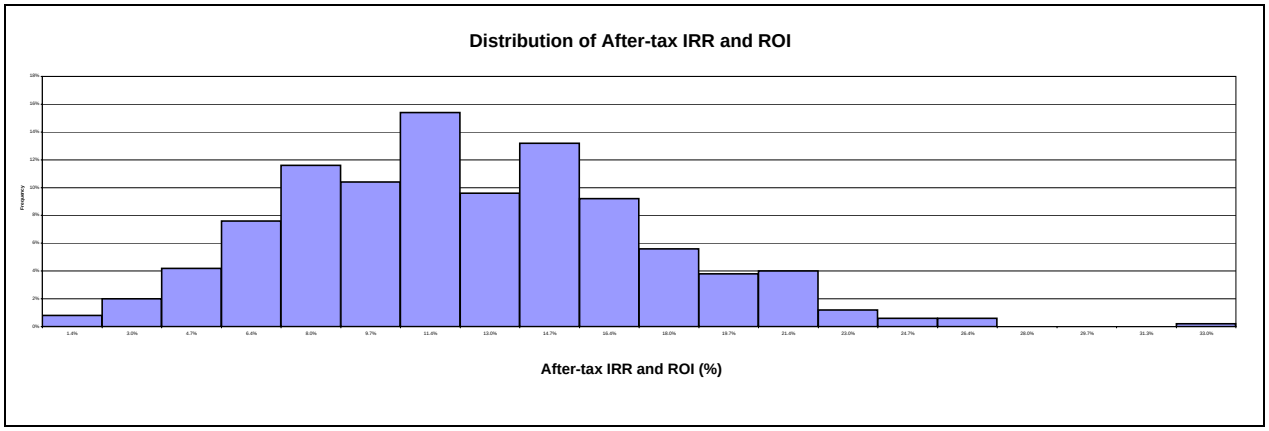
Risk Analysis for After-tax IRR and ROI

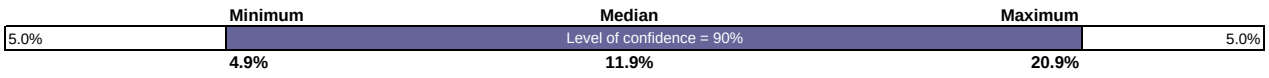
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0730	15%	0.0621	0.0840
RE delivered	MWh	37,164	15%	31,590	42,739
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	789,747	15%	671,285	908,209
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Peace Region
0% IRR
20 year lifetime of project

Peace Region

0% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Peace Region	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	8.7	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	6.0	
Average atmospheric pressure	kPa	91.0	60.0 to 103.0 kPa
Annual average temperature	°C	1	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	9.5	
Wind power density at hub height	W/m²	825	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	10,429	52,146	
Pressure adjustment coefficient	-	0.90	0.90	0.59 to 1.02
Temperature adjustment coefficient	-	1.05	1.05	0.98 to 1.15
Gross energy production	MWh	9,856	49,278	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,636	1,636	150 to 1,500 kWh/m²
Wind plant capacity factor	%	49%	49%	20% to 40%
Renewable energy delivered	MWh	8,641	**43,204**	
	kWh	8,640,804	43,204,021	
				Complete Cost Analysis sheet

Peace Region
0% IRR
40 year lifetime of project

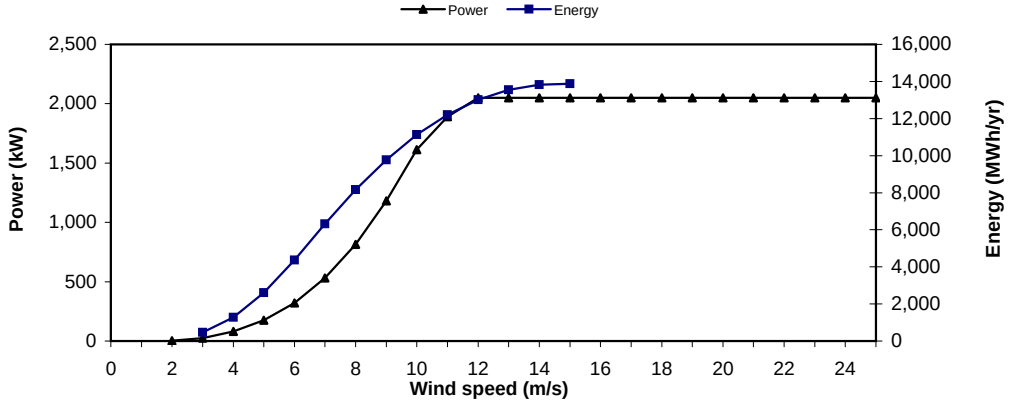
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Peace Region
0% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	43,204,021	CAD	0.003	CAD 108,010		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	197,060	CAD 17,735		-	-
Other - O&M	Cost	1	CAD	652,208	CAD 652,208		-	-
Contingencies	%	4%	CAD	867,003	CAD 34,680		-	-
Annual Costs - Total					**CAD 901,683**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Peace Region
0% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Peace Region			
Renewable energy delivered	MWh	43,204	Net GHG reduction	t_{CO2}/yr	19,519
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	780,755

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0730	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	901,683
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,092,811**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,155,622
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	432,040
				Annual Savings - Total	**CAD**	**3,587,662**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.4%			
After-tax IRR and ROI	%	0.4%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	9.9			
Year-to-positive cash flow	yr	16.6	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,317,013)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(543,715)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.20	Debt service coverage	-	1.21

Yearly Cash Flows

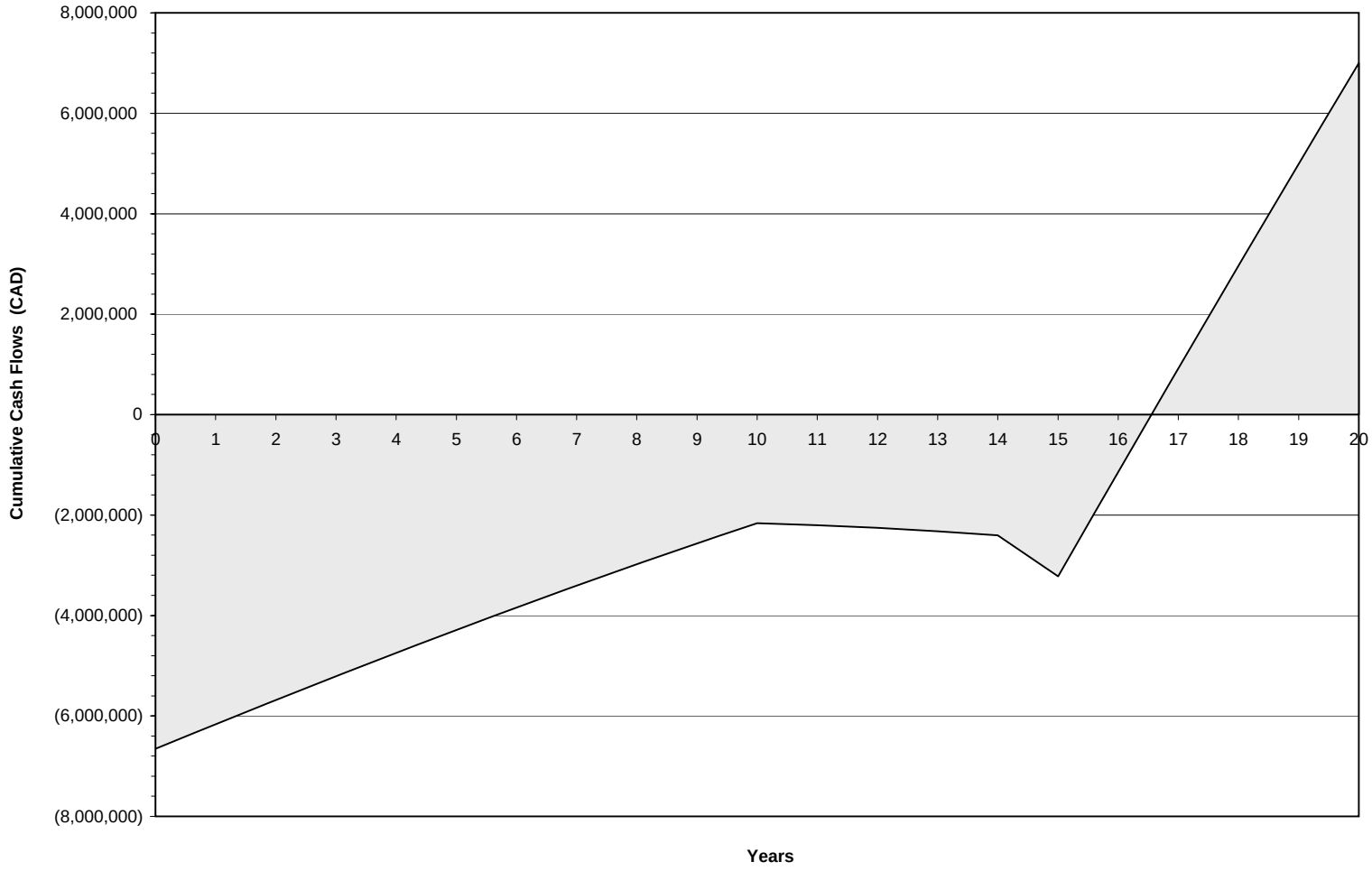
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	488,087	488,087	(6,164,114)
2	480,838	480,838	(5,683,276)
3	473,091	473,091	(5,210,185)
4	464,832	464,832	(4,745,353)
5	456,045	456,045	(4,289,308)
6	446,718	446,718	(3,842,590)
7	436,833	436,833	(3,405,757)
8	426,376	426,376	(2,979,381)
9	415,331	415,331	(2,564,049)
10	403,682	403,682	(2,160,367)
11	(40,629)	(40,629)	(2,200,996)
12	(53,538)	(53,538)	(2,254,534)
13	(67,104)	(67,104)	(2,321,638)
14	(81,343)	(81,343)	(2,402,981)
15	(820,424)	(820,424)	(3,223,405)
16	2,079,209	2,079,209	(1,144,197)
17	2,062,834	2,062,834	918,637
18	2,045,707	2,045,707	2,964,344
19	2,027,810	2,027,810	4,992,154
20	2,009,119	2,009,119	7,001,273
21	(37,312,601)	(37,312,601)	(30,311,328)
22	1,969,273	1,969,273	(28,342,055)
23	1,948,074	1,948,074	(26,393,981)
24	1,925,992	1,925,992	(24,467,990)
25	1,903,003	1,903,003	(22,564,986)
26	1,879,085	1,879,085	(20,685,901)
27	1,854,211	1,854,211	(18,831,690)
28	1,828,356	1,828,356	(17,003,334)
29	1,801,494	1,801,494	(15,201,840)
30	724,813	724,813	(14,477,026)
31	1,744,638	1,744,638	(12,732,388)
32	1,714,589	1,714,589	(11,017,799)
33	1,683,420	1,683,420	(9,334,378)
34	1,651,102	1,651,102	(7,683,277)
35	1,617,604	1,617,604	(6,065,673)
36	1,582,894	1,582,894	(4,482,779)
37	1,546,941	1,546,941	(2,935,838)
38	1,509,711	1,509,711	(1,426,126)
39	1,471,172	1,471,172	45,045
40	1,431,287	1,431,287	1,476,332

Peace Region
0% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Peace Region

Renewable energy delivered (MWh/yr): 43,204 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 19,519**



IRR and ROI: 0.4% **Year-to-positive cash flow: 16.6 yr** **Net Present Value: CAD -5,317,013**

Peace Region
0% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI	
Perform risk analysis too?	Yes	Sensitivity range	10%	
Project name		Threshold	0.0	%
Project location	Peace Region			

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh) 0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
38,884	-10%	-5.3%	-3.7%	-2.1%	-0.5%	1.2%
41,044	-5%	-4.3%	-2.7%	-0.9%	0.9%	3.1%
43,204	0%	-3.3%	-1.5%	**0.4%**	2.7%	5.5%
45,364	5%	-2.3%	-0.3%	2.0%	4.9%	8.6%
47,524	10%	-1.2%	1.1%	4.0%	7.8%	12.2%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh) 0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
23,947,923	-10%	-2.7%	-0.5%	2.1%	5.7%	10.9%
25,278,364	-5%	-3.0%	-1.1%	1.1%	3.9%	7.6%
26,608,804	0%	-3.3%	-1.5%	**0.4%**	2.7%	5.5%
27,939,244	5%	-3.6%	-1.9%	-0.1%	1.8%	4.1%
29,269,684	10%	-3.9%	-2.3%	-0.6%	1.2%	3.1%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh) 0.0657 -10%	0.0694 -5%	**0.0730 0%**	0.0767 5%	0.0803 10%
811,515	-10%	-1.7%	0.2%	2.3%	4.8%	8.0%
856,599	-5%	-2.5%	-0.7%	1.4%	3.7%	6.7%
901,683	0%	-3.3%	-1.5%	**0.4%**	2.7%	5.5%
946,768	5%	-4.2%	-2.4%	-0.5%	1.7%	4.3%
991,852	10%	-5.2%	-3.3%	-1.4%	0.7%	3.1%

Debt interest rate (%)		Debt ratio (%) 67.5% -10%	71.3% -5%	**75.0% 0%**	78.8% 5%	82.5% 10%
6.3%	-10%	1.3%	1.1%	0.9%	0.7%	0.6%
6.7%	-5%	1.0%	0.9%	0.7%	0.5%	0.3%
7.0%	0%	0.8%	0.6%	**0.4%**	0.2%	0.1%
7.4%	5%	0.6%	0.4%	0.2%	0.0%	-0.2%
7.7%	10%	0.4%	0.2%	0.0%	-0.2%	-0.4%

Debt interest rate (%)		Debt term (yr) 13.5 -10%	14.3 -5%	**15.0 0%**	15.8 5%	16.5 10%
6.3%	-10%	1.7%	1.3%	0.9%	1.3%	0.9%
6.7%	-5%	1.4%	1.0%	0.7%	1.0%	0.6%
7.0%	0%	1.2%	0.8%	**0.4%**	0.7%	0.3%
7.4%	5%	1.0%	0.6%	0.2%	0.5%	0.1%
7.7%	10%	0.8%	0.4%	0.0%	0.3%	-0.1%

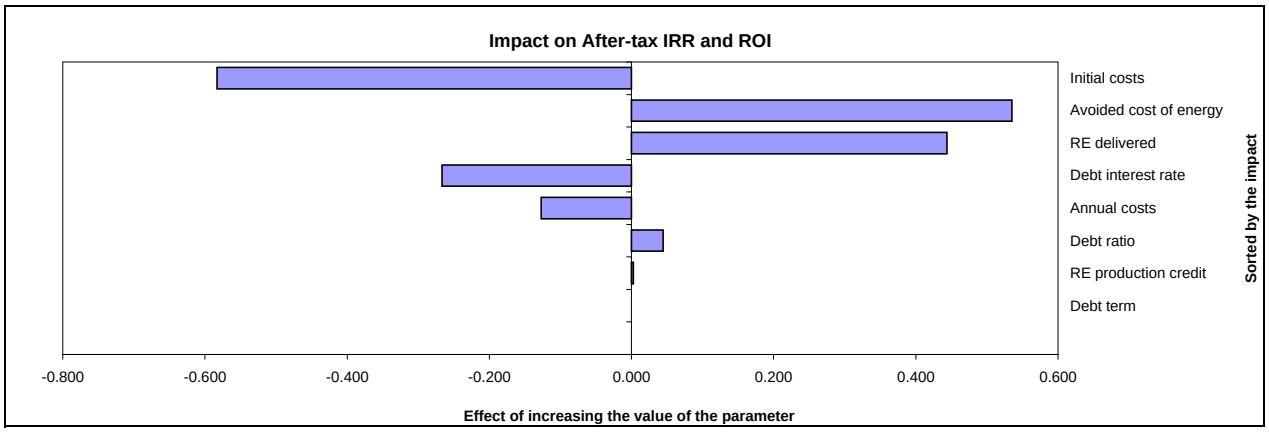
RE delivered (MWh)		RE production credit (CAD/kWh) 0.009 -10%	0.010 -5%	**0.010 0%**	0.011 5%	0.011 10%
38,884	-10%	-2.2%	-2.2%	-2.1%	-2.1%	-2.1%
41,044	-5%	-1.0%	-1.0%	-0.9%	-0.9%	-0.8%
43,204	0%	0.3%	0.4%	**0.4%**	0.5%	0.6%
45,364	5%	1.8%	1.9%	2.0%	2.1%	2.2%
47,524	10%	3.7%	3.8%	4.0%	4.2%	4.4%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

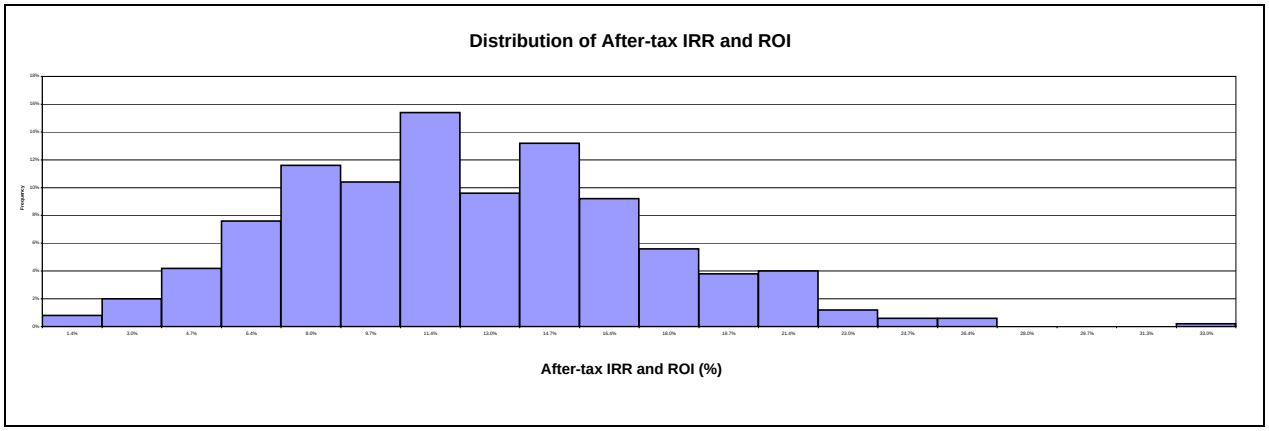
Risk Analysis for After-tax IRR and ROI

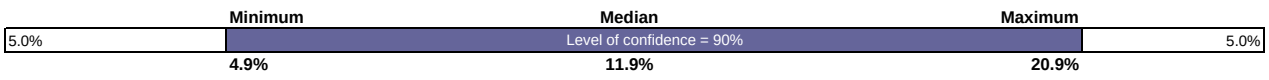
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0730	15%	0.0621	0.0840
RE delivered	MWh	43,204	15%	36,723	49,685
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	901,683	15%	766,431	1,036,936
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Peace Region
0% IRR
40 year lifetime of project

Peace Region

8% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Peace Region	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	9.1	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	6.3	
Average atmospheric pressure	kPa	91.0	60.0 to 103.0 kPa
Annual average temperature	°C	1	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	9.9	
Wind power density at hub height	W/m²	944	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	11,018	55,089	
Pressure adjustment coefficient	-	0.90	0.90	0.59 to 1.02
Temperature adjustment coefficient	-	1.05	1.05	0.98 to 1.15
Gross energy production	MWh	10,412	52,059	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,729	1,729	150 to 1,500 kWh/m²
Wind plant capacity factor	%	52%	52%	20% to 40%
Renewable energy delivered	MWh	9,128	**45,642**	
	kWh	9,128,390	45,641,949	
				Complete Cost Analysis sheet

Peace Region
8% IRR
20 year lifetime of project

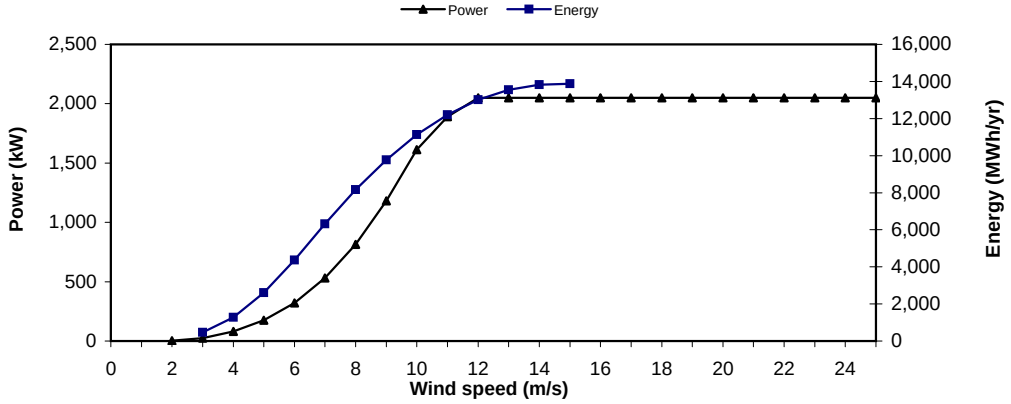
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Peace Region
8% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	45,641,949	CAD	0.003	CAD 114,105		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	203,155	CAD 18,284		-	-
Other - O&M	Cost	1	CAD	689,011	CAD 689,011		-	-
Contingencies	%	4%	CAD	910,450	CAD 36,418		-	-
Annual Costs - Total					**CAD 946,868**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Peace Region
8% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Peace Region			
Renewable energy delivered	MWh	45,642	Net GHG reduction	t_{CO2}/yr	20,620
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	412,406

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0730	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	946,868
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,137,995**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,333,688
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	456,419
				Annual Savings - Total	**CAD**	**3,790,107**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	8.1%			
After-tax IRR and ROI	%	8.1%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	9.4			
Year-to-positive cash flow	yr	15.5	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(1,000,726)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(117,545)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.85	Debt service coverage	-	1.28

Yearly Cash Flows

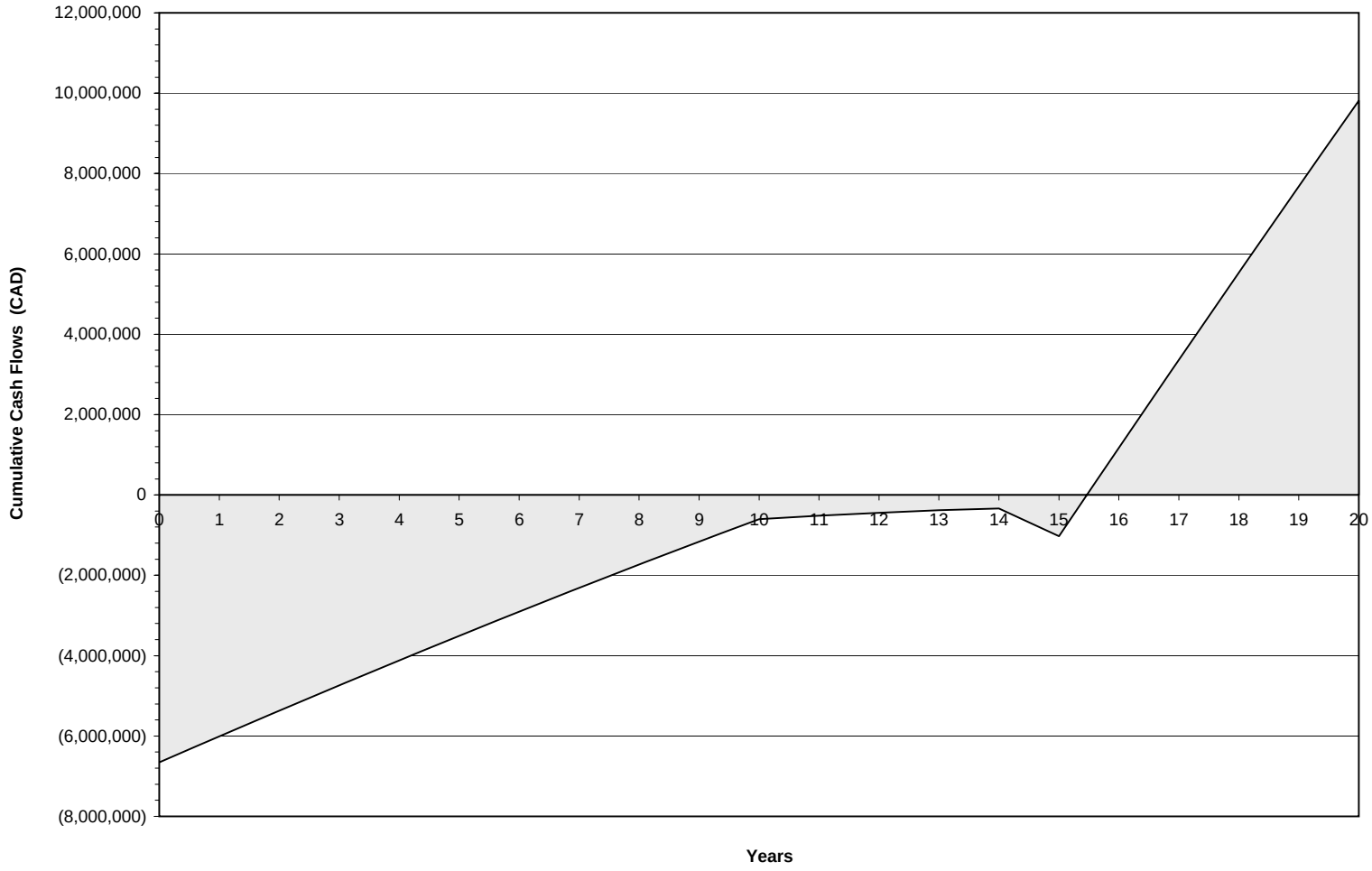
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	645,109	645,109	(6,007,092)
2	637,597	637,597	(5,369,495)
3	629,563	629,563	(4,739,932)
4	620,990	620,990	(4,118,942)
5	611,866	611,866	(3,507,076)
6	602,173	602,173	(2,904,904)
7	591,896	591,896	(2,313,008)
8	581,018	581,018	(1,731,990)
9	569,523	569,523	(1,162,467)
10	557,394	557,394	(605,073)
11	88,194	88,194	(516,879)
12	74,743	74,743	(442,136)
13	60,604	60,604	(381,532)
14	45,757	45,757	(335,775)
15	(693,966)	(693,966)	(1,029,740)
16	2,204,991	2,204,991	1,175,251
17	2,187,903	2,187,903	3,363,154
18	2,170,027	2,170,027	5,533,181
19	2,151,342	2,151,342	7,684,523
20	2,131,824	2,131,824	9,816,347

Peace Region
8% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Peace Region

Renewable energy delivered (MWh/yr): 45,642 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 20,620**



IRR and ROI: 8.1% **Year-to-positive cash flow: 15.5 yr** **Net Present Value: CAD -1,000,726**

Peace Region
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Peace Region		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
41,078	-10%	-1.8%	0.9%	3.5%	6.0%	8.5%
43,360	-5%	0.3%	3.1%	5.8%	8.4%	11.0%
45,642	0%	2.4%	5.3%	**8.1%**	10.9%	13.6%
47,924	5%	4.5%	7.5%	10.5%	13.4%	16.2%
50,206	10%	6.6%	9.7%	12.8%	15.9%	18.8%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
23,947,923	-10%	6.5%	9.7%	12.8%	15.9%	18.9%
25,278,364	-5%	4.3%	7.4%	10.3%	13.3%	16.1%
26,608,804	0%	2.4%	5.3%	**8.1%**	10.9%	13.6%
27,939,244	5%	0.7%	3.4%	6.1%	8.8%	11.4%
29,269,684	10%	-0.9%	1.8%	4.3%	6.9%	9.4%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
852,181	-10%	4.4%	7.2%	10.0%	12.7%	15.4%
899,524	-5%	3.4%	6.2%	9.0%	11.8%	14.5%
946,868	0%	2.4%	5.3%	**8.1%**	10.9%	13.6%
994,211	5%	1.3%	4.3%	7.2%	10.0%	12.7%
1,041,554	10%	0.3%	3.3%	6.2%	9.0%	11.8%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	8.9%	9.2%	9.5%	9.8%	10.3%
6.7%	-5%	8.4%	8.6%	8.8%	9.0%	9.3%
7.0%	0%	7.9%	8.0%	**8.1%**	8.2%	8.4%
7.4%	5%	7.4%	7.4%	7.4%	7.4%	7.4%
7.7%	10%	6.9%	6.8%	6.8%	6.7%	6.5%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.6%	9.5%	9.5%	10.4%	10.4%
6.7%	-5%	9.1%	8.9%	8.8%	9.7%	9.6%
7.0%	0%	8.5%	8.3%	**8.1%**	9.0%	8.8%
7.4%	5%	8.0%	7.7%	7.4%	8.3%	8.0%
7.7%	10%	7.5%	7.1%	6.8%	7.6%	7.2%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
41,078	-10%	3.1%	3.3%	3.5%	3.7%	3.9%
43,360	-5%	5.3%	5.6%	5.8%	6.0%	6.2%
45,642	0%	7.6%	7.9%	**8.1%**	8.4%	8.6%
47,924	5%	9.9%	10.2%	10.5%	10.7%	11.0%
50,206	10%	12.2%	12.5%	12.8%	13.1%	13.5%

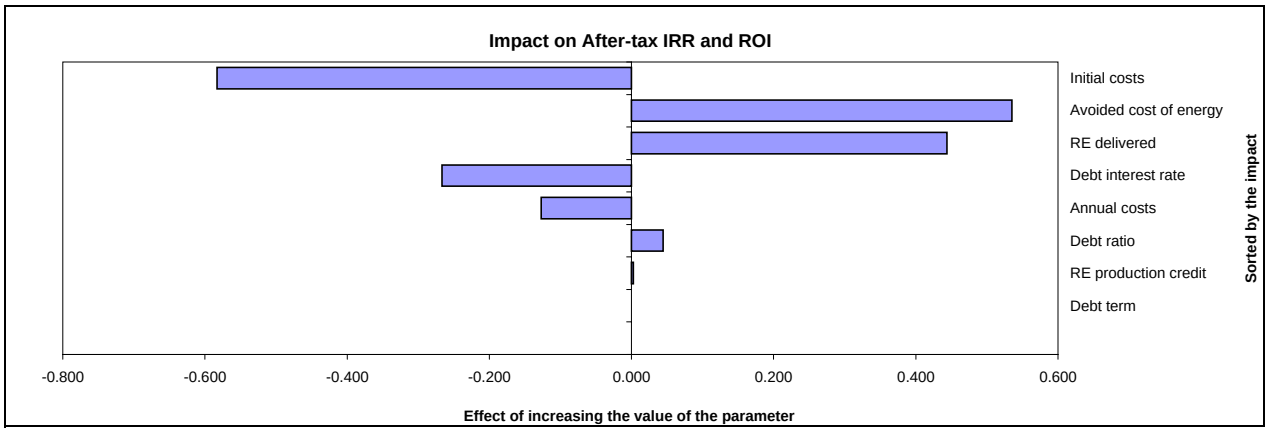
Peace Region
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

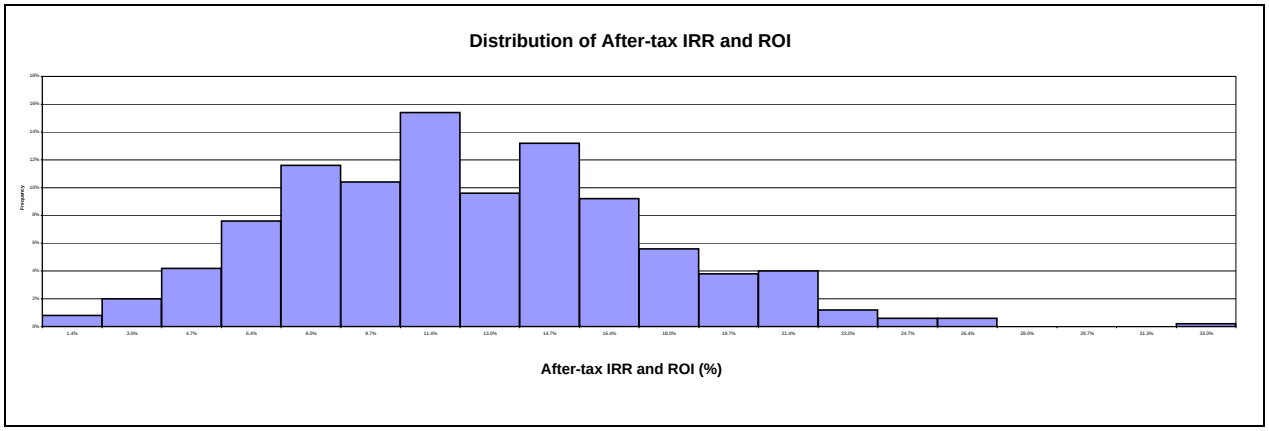
Risk Analysis for After-tax IRR and ROI

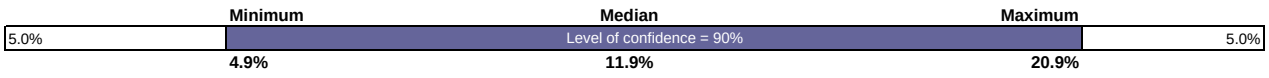
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0730	15%	0.0621	0.0840
RE delivered	MWh	45,642	15%	38,796	52,488
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	946,868	15%	804,838	1,088,898
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Peace Region
8% IRR
20 year lifetime of project

Peace Region

8% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Peace Region	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	10.3	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	7.1	
Average atmospheric pressure	kPa	91.0	60.0 to 103.0 kPa
Annual average temperature	°C	1	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	11.2	
Wind power density at hub height	W/m²	1,366	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	12,390	61,950	
Pressure adjustment coefficient	-	0.90	0.90	0.59 to 1.02
Temperature adjustment coefficient	-	1.05	1.05	0.98 to 1.15
Gross energy production	MWh	11,709	58,543	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,944	1,944	150 to 1,500 kWh/m²
Wind plant capacity factor	%	59%	59%	20% to 40%
Renewable energy delivered	MWh	10,265	**51,327**	
	kWh	10,265,336	51,326,682	
				Complete Cost Analysis sheet

Peace Region
8% IRR
40 year lifetime of project

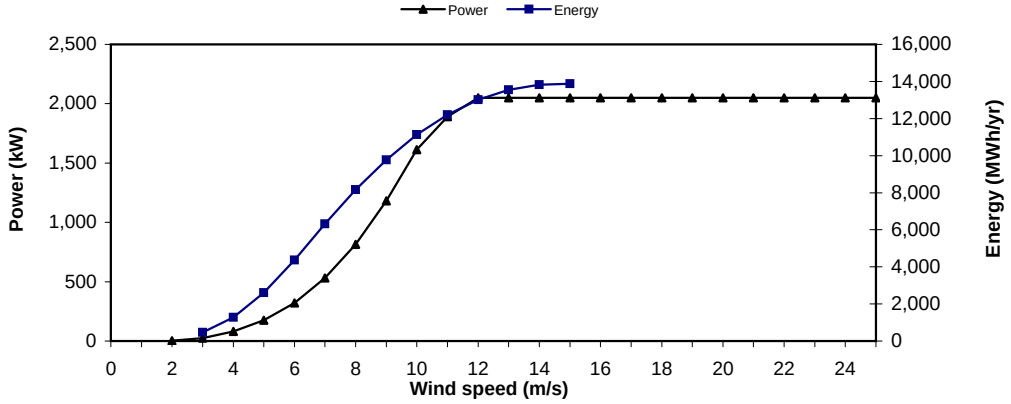
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Peace Region
8% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	51,326,682	CAD	0.003	CAD 128,317		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	217,367	CAD 19,563		-	-
Other - O&M	Cost	1	CAD	774,828	CAD 774,828		-	-
Contingencies	%	4%	CAD	1,011,757	CAD 40,470		-	-
Annual Costs - Total					**CAD 1,052,228**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		Go to GHG Analysis sheet

Peace Region
8% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Peace Region			
Renewable energy delivered	MWh	51,327	Net GHG reduction	t_{CO2}/yr	23,189
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	927,543

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0730	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	1,052,228
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,243,355**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,748,901
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	513,267
				Annual Savings - Total	**CAD**	**4,262,168**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	8.3%			
After-tax IRR and ROI	%	8.3%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8.3			
Year-to-positive cash flow	yr	6.8	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(646,309)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(66,091)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.90	Debt service coverage	-	1.45

Yearly Cash Flows

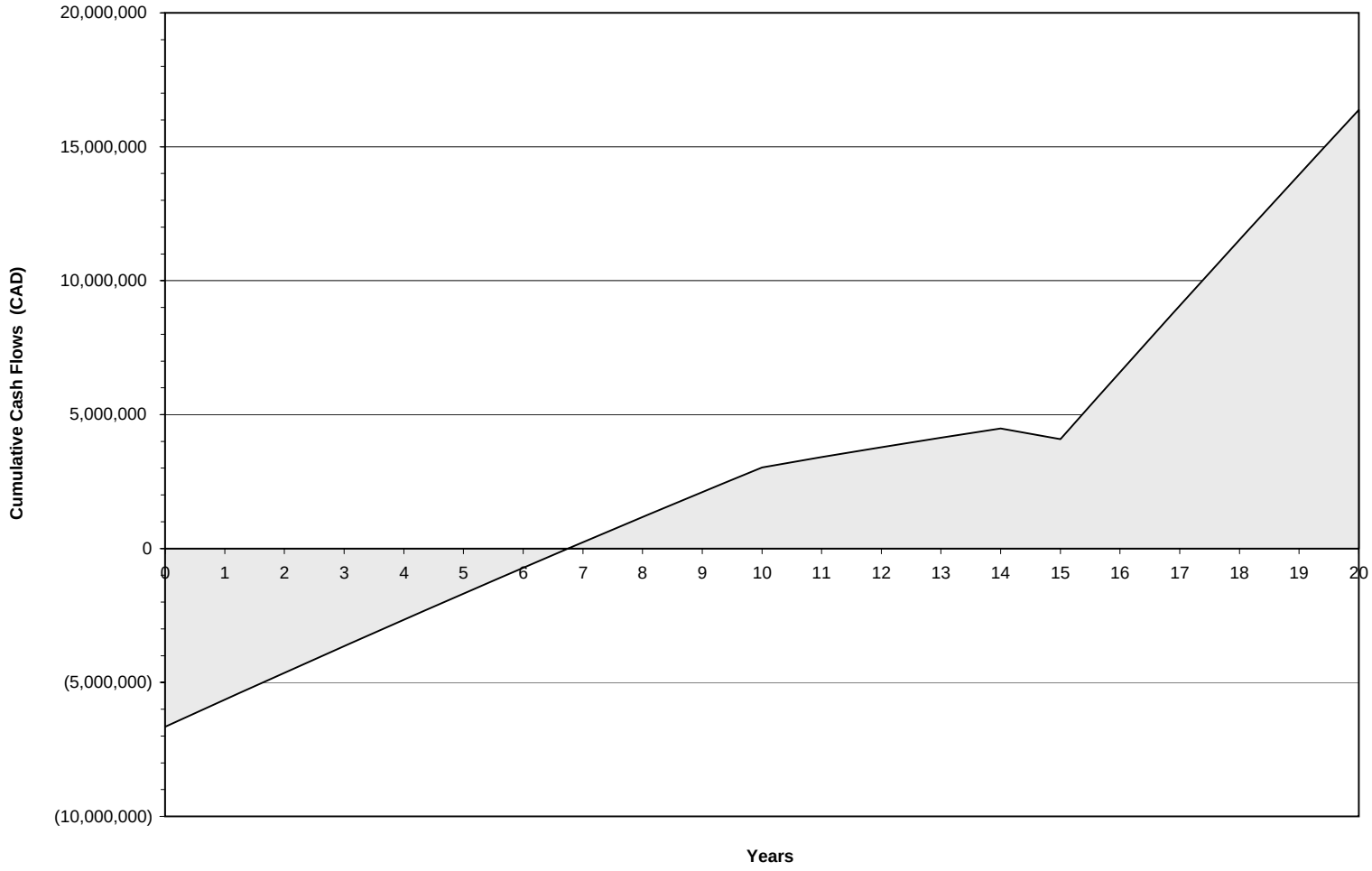
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	1,011,251	1,011,251	(5,640,950)
2	1,003,126	1,003,126	(4,637,824)
3	994,421	994,421	(3,643,403)
4	985,120	985,120	(2,658,283)
5	975,205	975,205	(1,683,077)
6	964,661	964,661	(718,417)
7	953,468	953,468	235,052
8	941,609	941,609	1,176,661
9	929,066	929,066	2,105,727
10	915,819	915,819	3,021,546
11	388,582	388,582	3,410,128
12	373,868	373,868	3,783,996
13	358,390	358,390	4,142,386
14	342,128	342,128	4,484,514
15	(399,090)	(399,090)	4,085,424
16	2,498,289	2,498,289	6,583,712
17	2,479,539	2,479,539	9,063,251
18	2,459,915	2,459,915	11,523,167
19	2,439,392	2,439,392	13,962,559
20	2,417,947	2,417,947	16,380,506
21	(36,906,663)	(36,906,663)	(20,526,157)
22	2,372,184	2,372,184	(18,153,973)
23	2,347,815	2,347,815	(15,806,158)
24	2,322,419	2,322,419	(13,483,739)
25	2,295,967	2,295,967	(11,187,772)
26	2,268,432	2,268,432	(8,919,341)
27	2,239,783	2,239,783	(6,679,558)
28	2,209,991	2,209,991	(4,469,566)
29	2,179,026	2,179,026	(2,290,541)
30	1,098,071	1,098,071	(1,192,469)
31	2,113,447	2,113,447	920,978
32	2,078,768	2,078,768	2,999,747
33	2,042,785	2,042,785	5,042,532
34	2,005,463	2,005,463	7,047,994
35	1,966,765	1,966,765	9,014,759
36	1,926,656	1,926,656	10,941,415
37	1,885,098	1,885,098	12,826,513
38	1,842,052	1,842,052	14,668,564
39	1,797,479	1,797,479	16,466,043
40	1,751,338	1,751,338	18,217,381

Peace Region
8% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Peace Region

Renewable energy delivered (MWh/yr): 51,327 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 23,189**



IRR and ROI: 8.3% **Year-to-positive cash flow: 6.8 yr** **Net Present Value: CAD -646,309**

Peace Region
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Peace Region		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
46,194	-10%	-2.4%	-0.3%	2.2%	5.3%	9.2%
48,760	-5%	-1.0%	1.5%	4.7%	9.0%	13.6%
51,327	0%	0.5%	3.8%	**8.3%**	13.3%	17.7%
53,893	5%	2.4%	6.9%	12.5%	17.3%	21.4%
56,459	10%	5.1%	11.1%	16.5%	20.9%	24.8%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
23,947,923	-10%	2.6%	9.0%	15.8%	20.7%	24.8%
25,278,364	-5%	1.4%	5.6%	11.7%	16.9%	21.2%
26,608,804	0%	0.5%	3.8%	**8.3%**	13.3%	17.7%
27,939,244	5%	-0.1%	2.6%	6.0%	10.3%	14.5%
29,269,684	10%	-0.6%	1.7%	4.5%	7.9%	11.8%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0657	0.0694	**0.0730**	0.0767	0.0803
		-10%	-5%	0%	5%	10%
947,005	-10%	3.1%	7.0%	11.8%	16.3%	20.2%
999,616	-5%	1.8%	5.3%	10.1%	14.9%	19.0%
1,052,228	0%	0.5%	3.8%	**8.3%**	13.3%	17.7%
1,104,839	5%	-0.7%	2.3%	6.4%	11.7%	16.4%
1,157,450	10%	-1.9%	0.9%	4.6%	9.8%	14.9%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.3%	9.7%	10.2%	11.0%	12.3%
6.7%	-5%	8.6%	8.9%	9.2%	9.7%	10.4%
7.0%	0%	8.0%	8.1%	**8.3%**	8.5%	8.7%
7.4%	5%	7.4%	7.4%	7.4%	7.4%	7.4%
7.7%	10%	6.8%	6.7%	6.6%	6.5%	6.4%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	10.3%	10.2%	10.2%	11.6%	11.8%
6.7%	-5%	9.5%	9.3%	9.2%	10.5%	10.5%
7.0%	0%	8.8%	8.5%	**8.3%**	9.5%	9.3%
7.4%	5%	8.1%	7.7%	7.4%	8.5%	8.1%
7.7%	10%	7.5%	7.1%	6.6%	7.6%	7.1%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
46,194	-10%	2.0%	2.1%	2.2%	2.3%	2.4%
48,760	-5%	4.3%	4.5%	4.7%	4.9%	5.2%
51,327	0%	7.6%	7.9%	**8.3%**	8.7%	9.1%
53,893	5%	11.6%	12.0%	12.5%	13.0%	13.5%
56,459	10%	15.5%	16.0%	16.5%	17.0%	17.5%

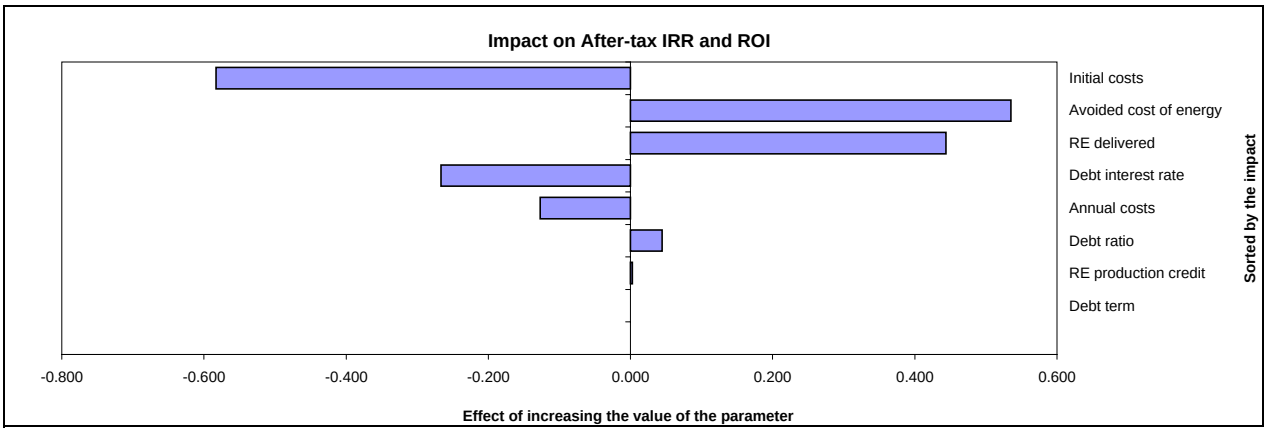
Peace Region
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

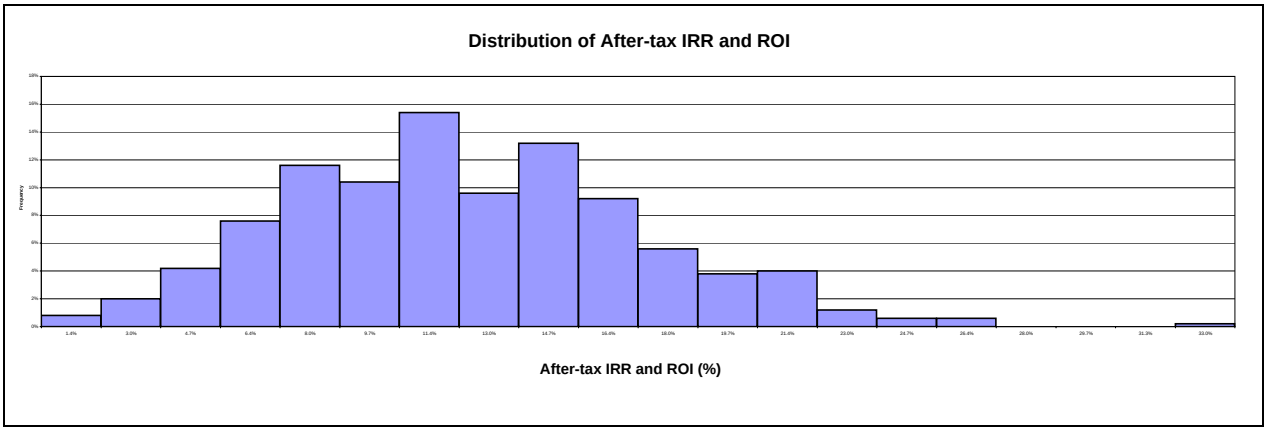
Risk Analysis for After-tax IRR and ROI

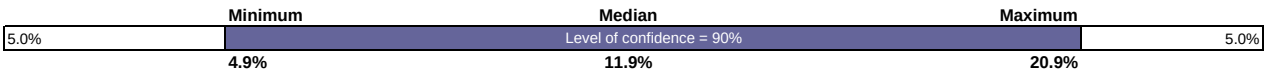
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0730	15%	0.0621	0.0840
RE delivered	MWh	51,327	15%	43,628	59,026
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	1,052,228	15%	894,393	1,210,062
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Peace Region
8% IRR
40 year lifetime of project

Southern and Eastern Interior Region

0% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Southern and Eastern Interior	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	7.9	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.4	
Average atmospheric pressure	kPa	88.0	60.0 to 103.0 kPa
Annual average temperature	°C	4	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	2000	→	Complete Equipment Data sheet
Number of turbines	-	5		
Wind plant capacity	kW	10,000		
Hub height	m	100.0		6.0 to 100.0 m
Wind speed at hub height	m/s	8.6		
Wind power density at hub height	W/m²	618		
Array losses	%	5%		0% to 20%
Airfoil soiling and/or icing losses	%	2%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	4%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	9,148	45,738	
Pressure adjustment coefficient	-	0.87	0.87	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	8,277	41,384	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,374	1,374	150 to 1,500 kWh/m²
Wind plant capacity factor	%	41%	41%	20% to 40%
Renewable energy delivered	MWh	7,257	**36,283**	
	kWh	7,256,631	36,283,157	
				Complete Cost Analysis sheet

Southern and Eastern Interior
0% IRR
20 year lifetime of project

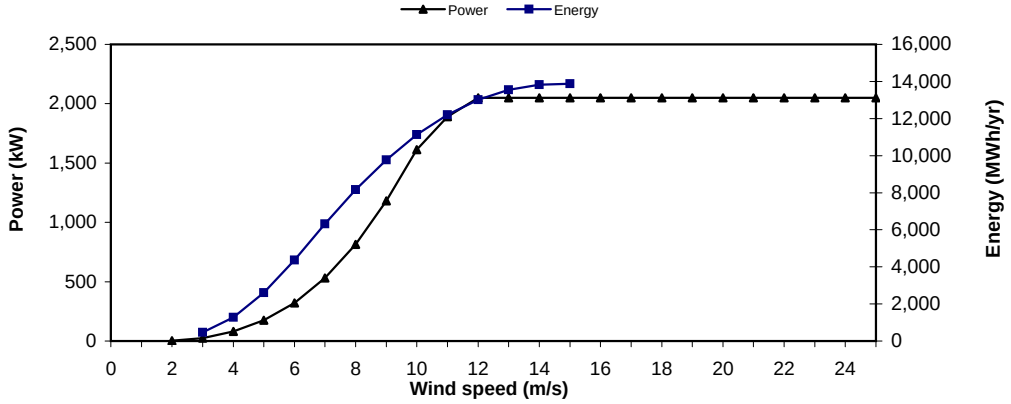
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Southern and Eastern Interior
0% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	36,283,157	CAD	0.003	CAD 90,708		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	179,758	CAD 16,178		-	-
Other - O&M	Cost	1	CAD	547,731	CAD 547,731		-	-
Contingencies	%	4%	CAD	743,667	CAD 29,747		-	-
Annual Costs - Total					**CAD 773,413**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Southern and Eastern Interior
0% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Southern and Eastern Interior			
Renewable energy delivered	MWh	36,283	Net GHG reduction	t_{CO2}/yr	16,392
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	327,843

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0754	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	773,413
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,964,541**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	2,734,662
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	362,832
				Annual Savings - Total	**CAD**	**3,097,493**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.6%			
After-tax IRR and ROI	%	0.6%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	11.4			
Year-to-positive cash flow	yr	19.5	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,078,929)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(596,569)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.24	Debt service coverage	-	0.50

Yearly Cash Flows

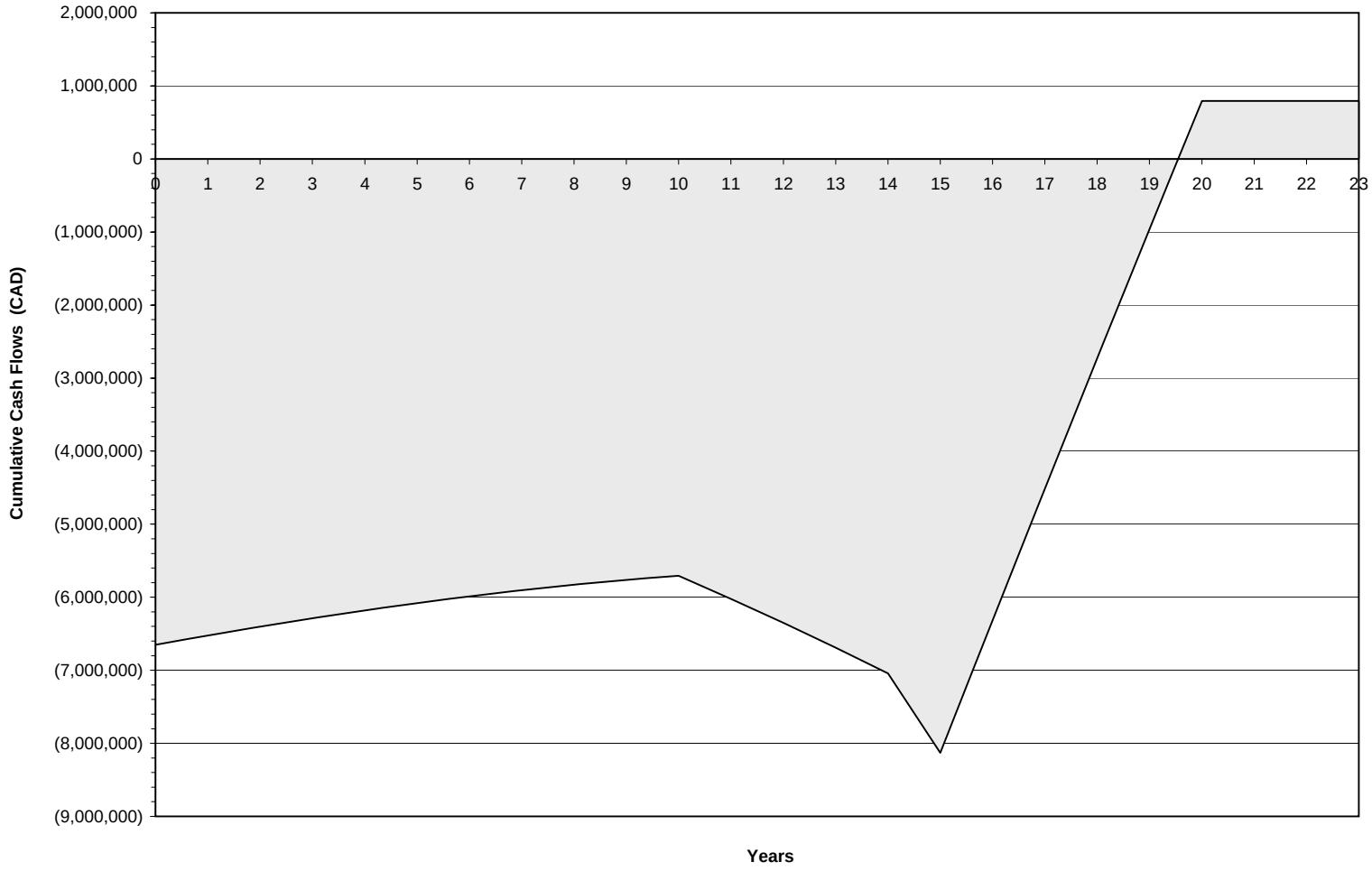
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	127,290	127,290	(6,524,911)
2	121,213	121,213	(6,403,698)
3	114,709	114,709	(6,288,989)
4	107,767	107,767	(6,181,222)
5	100,373	100,373	(6,080,849)
6	92,515	92,515	(5,988,334)
7	84,181	84,181	(5,904,153)
8	75,356	75,356	(5,828,797)
9	66,028	66,028	(5,762,769)
10	56,182	56,182	(5,706,587)
11	(317,028)	(317,028)	(6,023,615)
12	(327,953)	(327,953)	(6,351,568)
13	(339,440)	(339,440)	(6,691,008)
14	(351,505)	(351,505)	(7,042,513)
15	(1,088,312)	(1,088,312)	(8,130,825)
16	1,813,697	1,813,697	(6,317,129)
17	1,799,802	1,799,802	(4,517,326)
18	1,785,265	1,785,265	(2,732,062)
19	1,770,066	1,770,066	(961,996)
20	1,754,188	1,754,188	792,192

Southern and Eastern Interior
0% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Southern and Eastern Interior

Renewable energy delivered (MWh/yr): 36,283 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 16,392**



IRR and ROI: 0.6% **Year-to-positive cash flow: 19.5 yr** **Net Present Value: CAD -5,078,929**

Southern and Eastern Interior
0% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Southern and Eastern Interior		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
32,655	-10%	-7.6%	-5.3%	-3.1%	-1.0%	1.1%
34,469	-5%	-5.9%	-3.5%	-1.2%	1.0%	3.1%
36,283	0%	-4.1%	-1.7%	**0.6%**	2.9%	5.2%
38,097	5%	-2.5%	0.1%	2.5%	4.9%	7.2%
39,911	10%	-0.8%	1.9%	4.4%	6.9%	9.3%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-1.0%	1.7%	4.3%	6.8%	9.3%
25,278,364	-5%	-2.6%	-0.1%	2.4%	4.8%	7.1%
26,608,804	0%	-4.1%	-1.7%	**0.6%**	2.9%	5.2%
27,939,244	5%	-5.5%	-3.2%	-0.9%	1.3%	3.4%
29,269,684	10%	-6.7%	-4.5%	-2.3%	-0.2%	1.9%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
696,072	-10%	-2.4%	-0.1%	2.2%	4.5%	6.7%
734,743	-5%	-3.3%	-0.9%	1.4%	3.7%	5.9%
773,413	0%	-4.1%	-1.7%	**0.6%**	2.9%	5.2%
812,084	5%	-5.1%	-2.6%	-0.2%	2.1%	4.4%
850,755	10%	-6.0%	-3.5%	-1.0%	1.3%	3.6%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	2.5%	2.2%	1.8%	1.5%	1.0%
6.7%	-5%	2.0%	1.6%	1.2%	0.8%	0.3%
7.0%	0%	1.5%	1.1%	**0.6%**	0.1%	-0.4%
7.4%	5%	1.0%	0.6%	0.0%	-0.5%	-1.1%
7.7%	10%	0.5%	0.0%	-0.5%	-1.2%	-1.8%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	3.1%	2.5%	1.8%	2.6%	1.9%
6.7%	-5%	2.7%	2.0%	1.2%	2.0%	1.1%
7.0%	0%	2.2%	1.5%	**0.6%**	1.4%	0.4%
7.4%	5%	1.8%	1.0%	0.0%	0.8%	-0.3%
7.7%	10%	1.4%	0.5%	-0.5%	0.2%	-1.1%

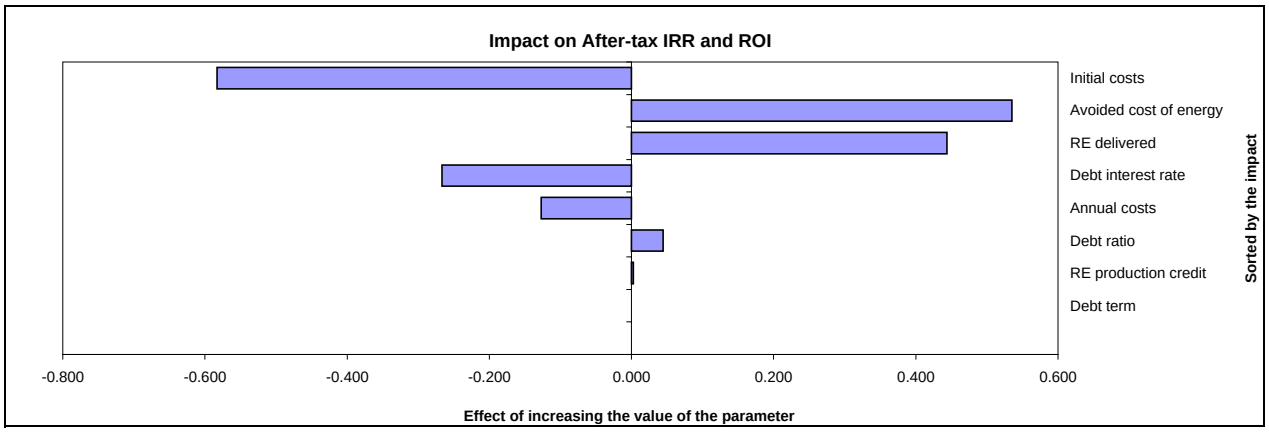
RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
32,655	-10%	-3.3%	-3.2%	-3.1%	-3.0%	-2.9%
34,469	-5%	-1.5%	-1.4%	-1.2%	-1.1%	-1.0%
36,283	0%	0.3%	0.5%	**0.6%**	0.8%	0.9%
38,097	5%	2.2%	2.3%	2.5%	2.7%	2.9%
39,911	10%	4.0%	4.2%	4.4%	4.6%	4.8%

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

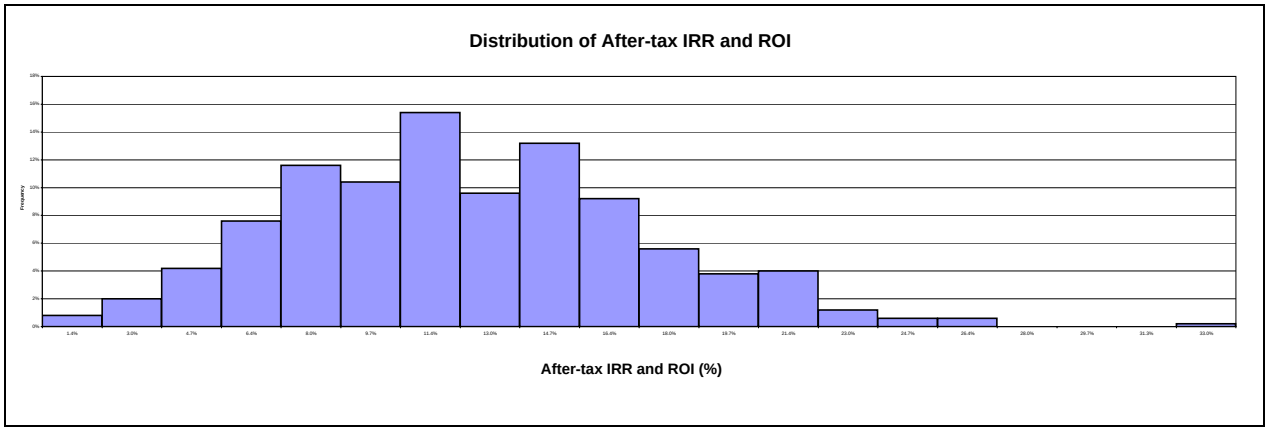
Risk Analysis for After-tax IRR and ROI

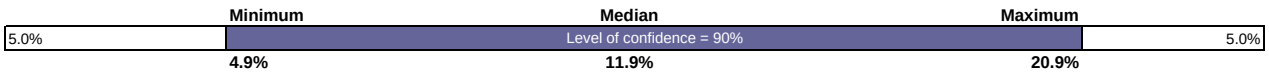
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0754	15%	0.0641	0.0867
RE delivered	MWh	36,283	15%	30,841	41,726
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	773,413	15%	657,401	889,425
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Southern and Eastern Interior
0% IRR
20 year lifetime of project

Southern and Eastern Interior Region

0% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Central Eastern Interior	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	8.6	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.9	
Average atmospheric pressure	kPa	88.0	60.0 to 103.0 kPa
Annual average temperature	°C	4	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	9.4	
Wind power density at hub height	W/m²	797	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	10,282	51,410	
Pressure adjustment coefficient	-	0.87	0.87	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	9,303	46,516	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,545	1,545	150 to 1,500 kWh/m²
Wind plant capacity factor	%	47%	47%	20% to 40%
Renewable energy delivered	MWh	8,157	**40,783**	
	kWh	8,156,516	40,782,581	
				Complete Cost Analysis sheet

Southern and Eastern Interior
0% IRR
40 year lifetime of project

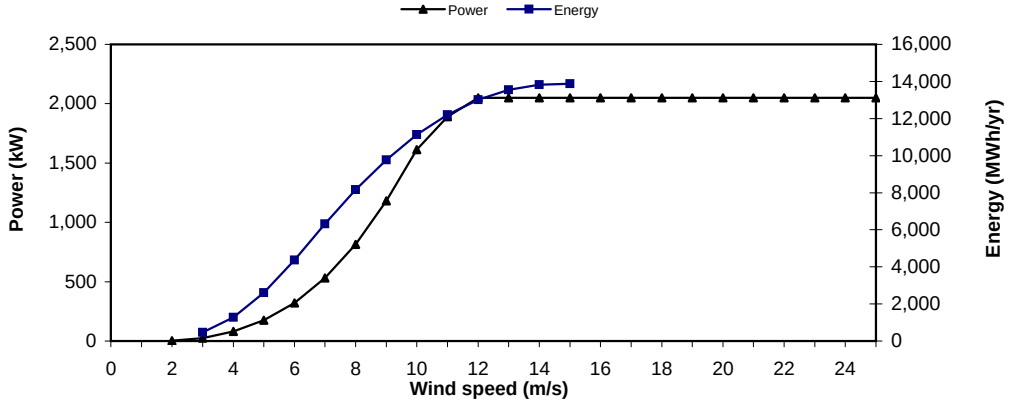
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Southern and Eastern Interior
0% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	40,782,581	CAD	0.003	CAD 101,956		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	191,006	CAD 17,191		-	-
Other - O&M	Cost	1	CAD	615,654	CAD 615,654		-	-
Contingencies	%	4%	CAD	823,851	CAD 32,954		-	-
Annual Costs - Total					**CAD 856,805**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Southern and Eastern Interior
0% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Central Eastern Interior			
Renewable energy delivered	MWh	40,783	Net GHG reduction	t_{CO2}/yr	18,425
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	736,997

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0754	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	856,805
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,047,933**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,073,783
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	407,826
				Annual Savings - Total	**CAD**	**3,481,609**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.2%			
After-tax IRR and ROI	%	0.2%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	10.1			
Year-to-positive cash flow	yr	16.9	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,731,260)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(586,075)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.14	Debt service coverage	-	1.18

Yearly Cash Flows

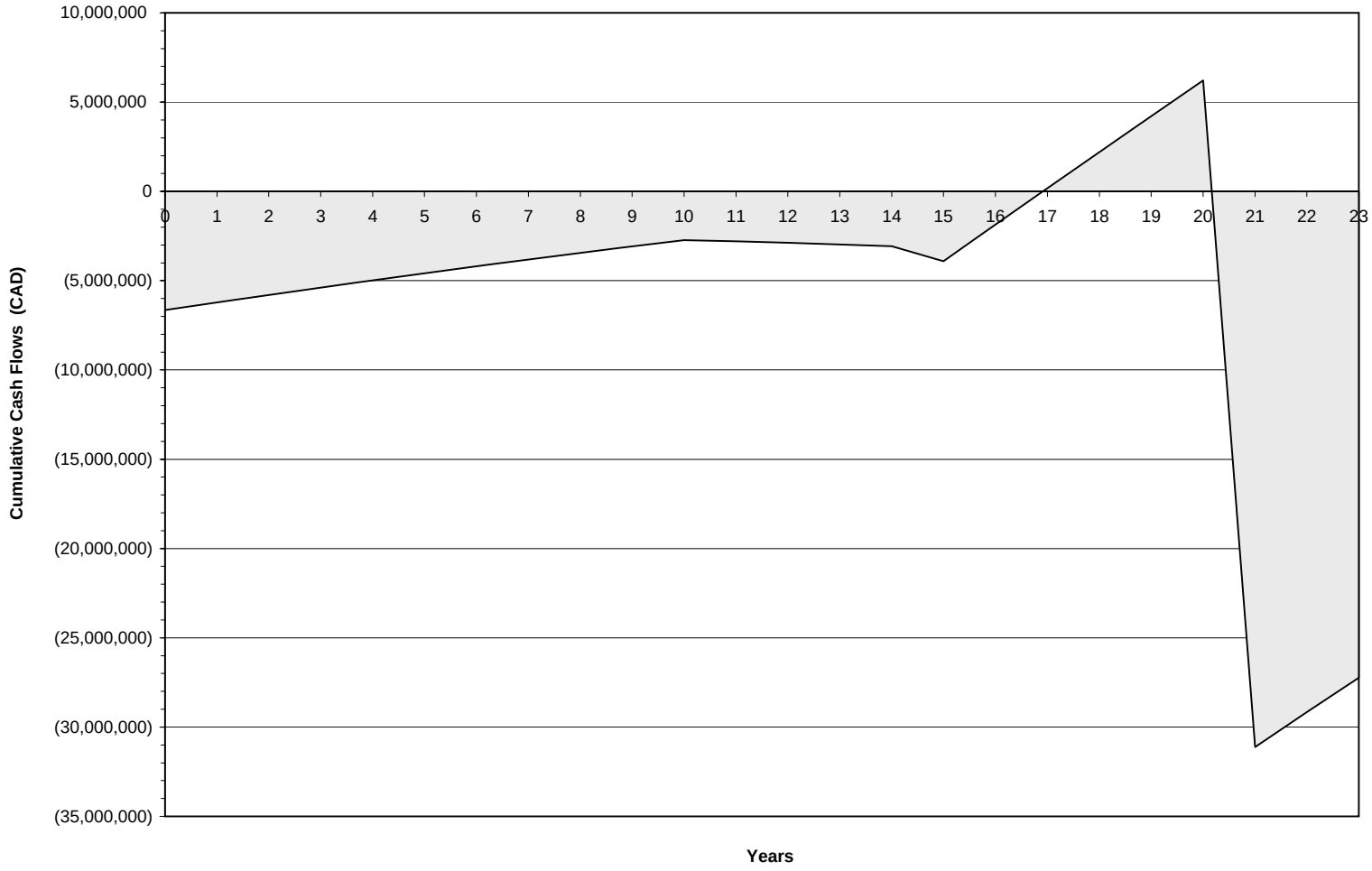
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	427,625	427,625	(6,224,576)
2	421,115	421,115	(5,803,461)
3	414,134	414,134	(5,389,327)
4	406,667	406,667	(4,982,660)
5	398,702	398,702	(4,583,958)
6	390,224	390,224	(4,193,734)
7	381,219	381,219	(3,812,515)
8	371,672	371,672	(3,440,842)
9	361,568	361,568	(3,079,274)
10	350,892	350,892	(2,728,382)
11	(68,198)	(68,198)	(2,796,580)
12	(80,068)	(80,068)	(2,876,648)
13	(92,559)	(92,559)	(2,969,206)
14	(105,688)	(105,688)	(3,074,895)
15	(843,623)	(843,623)	(3,918,517)
16	2,057,194	2,057,194	(1,861,323)
17	2,042,041	2,042,041	180,718
18	2,026,177	2,026,177	2,206,895
19	2,009,581	2,009,581	4,216,477
20	1,992,235	1,992,235	6,208,712
21	(37,328,099)	(37,328,099)	(31,119,387)
22	1,955,206	1,955,206	(29,164,182)
23	1,935,481	1,935,481	(27,228,701)
24	1,914,919	1,914,919	(25,313,782)
25	1,893,500	1,893,500	(23,420,282)
26	1,871,198	1,871,198	(21,549,085)
27	1,847,990	1,847,990	(19,701,095)
28	1,823,852	1,823,852	(17,877,242)
29	1,798,759	1,798,759	(16,078,483)
30	723,902	723,902	(15,354,581)
31	1,745,605	1,745,605	(13,608,976)
32	1,717,490	1,717,490	(11,891,486)
33	1,688,314	1,688,314	(10,203,172)
34	1,658,048	1,658,048	(8,545,124)
35	1,626,662	1,626,662	(6,918,461)
36	1,594,128	1,594,128	(5,324,333)
37	1,560,415	1,560,415	(3,763,919)
38	1,525,490	1,525,490	(2,238,428)
39	1,489,324	1,489,324	(749,105)
40	1,451,881	1,451,881	702,776

Southern and Eastern Interior
0% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Central Eastern Interior

Renewable energy delivered (MWh/yr): 40,783 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 18,425**



IRR and ROI: 0.2% **Year-to-positive cash flow: 16.9 yr** **Net Present Value: CAD -5,731,260**

Southern and Eastern Interior
0% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Central Eastern Interior		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
36,704	-10%	-5.2%	-3.7%	-2.3%	-0.7%	0.9%
38,743	-5%	-4.3%	-2.7%	-1.1%	0.7%	2.6%
40,783	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.7%
42,822	5%	-2.4%	-0.5%	1.7%	4.2%	7.5%
44,861	10%	-1.3%	0.9%	3.4%	6.8%	10.8%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-2.7%	-0.7%	1.7%	4.8%	9.3%
25,278,364	-5%	-3.1%	-1.2%	0.8%	3.3%	6.5%
26,608,804	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.7%
27,939,244	5%	-3.6%	-2.0%	-0.3%	1.5%	3.6%
29,269,684	10%	-3.9%	-2.3%	-0.8%	0.9%	2.7%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
771,124	-10%	-1.8%	-0.1%	1.9%	4.2%	6.9%
813,965	-5%	-2.6%	-0.8%	1.0%	3.2%	5.8%
856,805	0%	-3.4%	-1.6%	**0.2%**	2.3%	4.7%
899,645	5%	-4.2%	-2.4%	-0.6%	1.4%	3.7%
942,485	10%	-5.0%	-3.3%	-1.5%	0.5%	2.7%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.0%	0.8%	0.6%	0.5%	0.3%
6.7%	-5%	0.8%	0.6%	0.4%	0.2%	0.1%
7.0%	0%	0.6%	0.4%	**0.2%**	0.0%	-0.2%
7.4%	5%	0.4%	0.2%	0.0%	-0.2%	-0.4%
7.7%	10%	0.2%	0.0%	-0.2%	-0.4%	-0.6%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.4%	1.0%	0.6%	1.0%	0.6%
6.7%	-5%	1.1%	0.8%	0.4%	0.7%	0.3%
7.0%	0%	0.9%	0.6%	**0.2%**	0.5%	0.1%
7.4%	5%	0.7%	0.4%	0.0%	0.2%	-0.1%
7.7%	10%	0.5%	0.2%	-0.2%	0.0%	-0.3%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
36,704	-10%	-2.3%	-2.3%	-2.3%	-2.2%	-2.2%
38,743	-5%	-1.2%	-1.1%	-1.1%	-1.0%	-1.0%
40,783	0%	0.1%	0.1%	**0.2%**	0.3%	0.3%
42,822	5%	1.5%	1.6%	1.7%	1.8%	1.8%
44,861	10%	3.2%	3.3%	3.4%	3.6%	3.7%

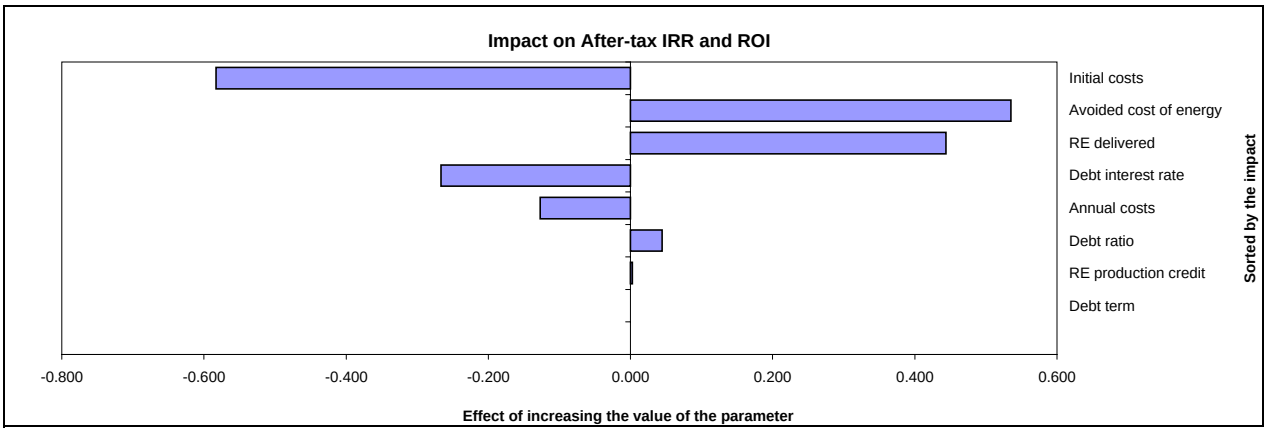
Southern and Eastern Interior
0% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

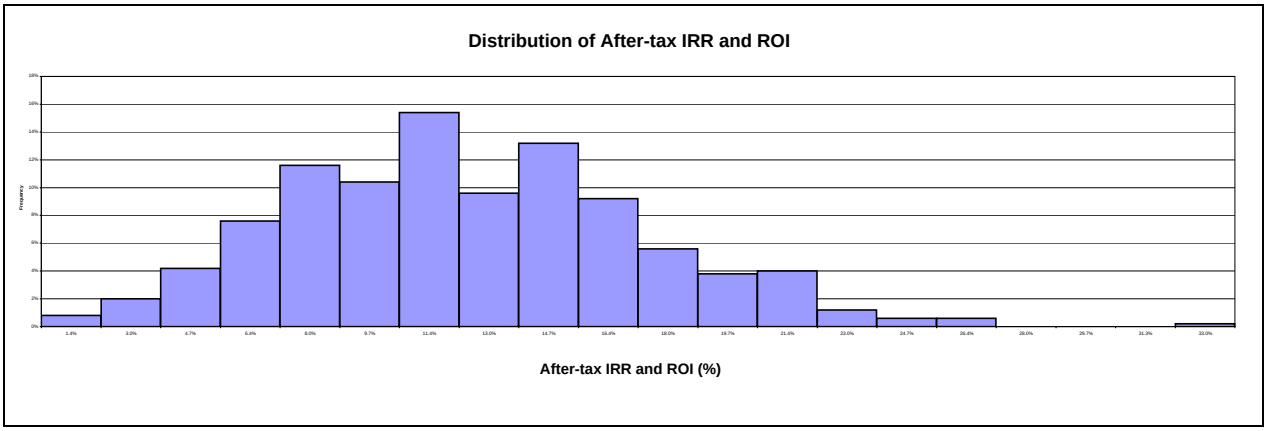
Risk Analysis for After-tax IRR and ROI

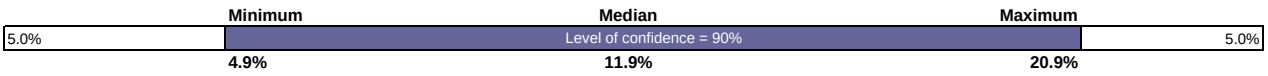
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0754	15%	0.0641	0.0867
RE delivered	MWh	40,783	15%	34,665	46,900
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	856,805	15%	728,284	985,326
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Southern and Eastern Interior
0% IRR
40 year lifetime of project

Southern and Eastern Interior Region

8% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Central Eastern Interior	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	9.1	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	6.3	
Average atmospheric pressure	kPa	88.0	60.0 to 103.0 kPa
Annual average temperature	°C	4	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	2000	→	Complete Equipment Data sheet
Number of turbines	-	5		
Wind plant capacity	kW	10,000		
Hub height	m	100.0		6.0 to 100.0 m
Wind speed at hub height	m/s	9.9		
Wind power density at hub height	W/m²	944		
Array losses	%	5%		0% to 20%
Airfoil soiling and/or icing losses	%	2%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	4%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	11,018	55,089	
Pressure adjustment coefficient	-	0.87	0.87	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	9,969	49,844	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,655	1,655	150 to 1,500 kWh/m²
Wind plant capacity factor	%	50%	50%	20% to 40%
Renewable energy delivered	MWh	8,740	**43,700**	
	kWh	8,740,071	43,700,355	
				Complete Cost Analysis sheet

Southern and Eastern Interior
8% IRR
20 year lifetime of project

RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
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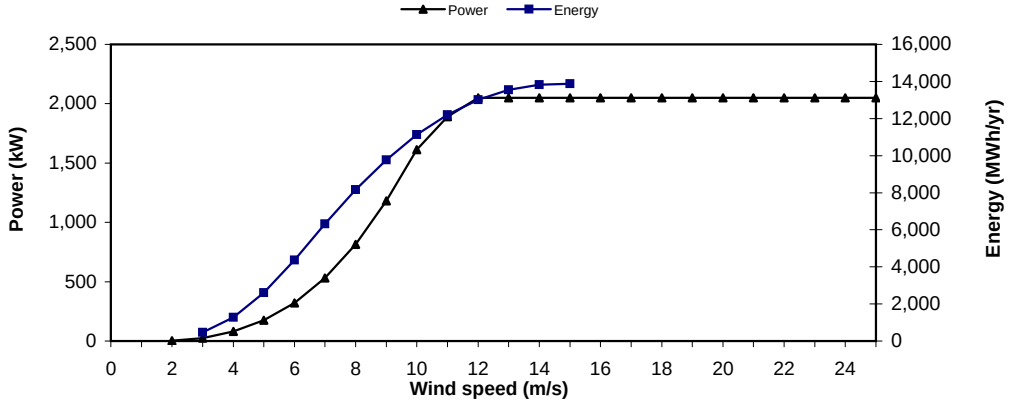
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Southern and Eastern Interior
8% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	43,700,355	CAD	0.003	CAD 109,251		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	198,301	CAD 17,847		-	-
Other - O&M	Cost	1	CAD	659,701	CAD 659,701		-	-
Contingencies	%	4%	CAD	875,849	CAD 35,034		-	-
Annual Costs - Total					**CAD 910,882**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Southern and Eastern Interior
8% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Central Eastern Interior			
Renewable energy delivered	MWh	43,700	Net GHG reduction	t_{CO2}/yr	19,743
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	394,862

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0754	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	910,882
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,102,010**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,293,696
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	437,004
				Annual Savings - Total	**CAD**	**3,730,699**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	7.9%			
After-tax IRR and ROI	%	7.9%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	9.4			
Year-to-positive cash flow	yr	15.5	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(1,101,609)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(129,395)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.83	Debt service coverage	-	1.27

Yearly Cash Flows

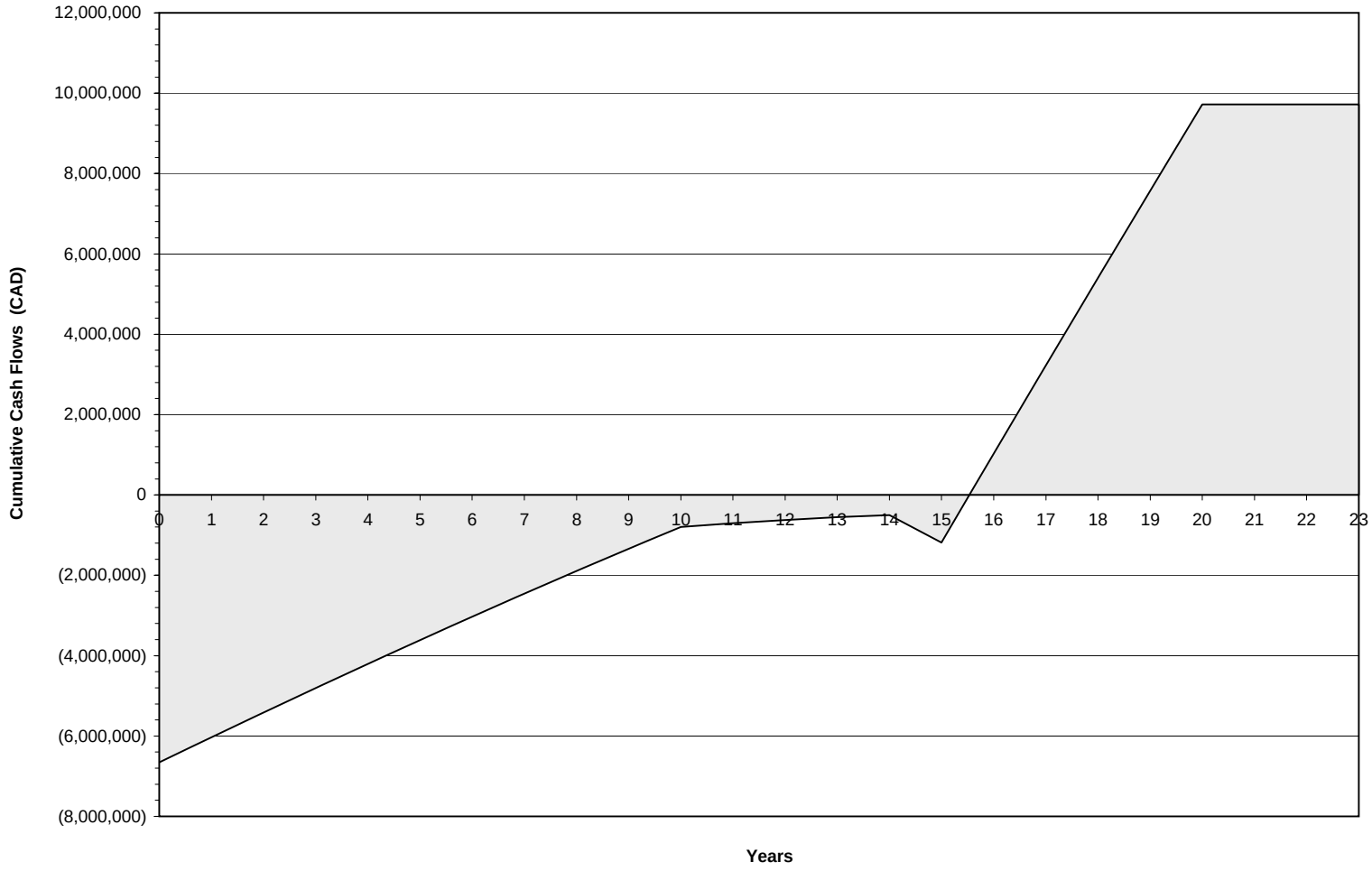
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	622,386	622,386	(6,029,815)
2	615,595	615,595	(5,414,220)
3	608,304	608,304	(4,805,917)
4	600,497	600,497	(4,205,419)
5	592,162	592,162	(3,613,258)
6	583,281	583,281	(3,029,976)
7	573,842	573,842	(2,456,135)
8	563,826	563,826	(1,892,308)
9	553,220	553,220	(1,339,089)
10	542,005	542,005	(797,084)
11	93,162	93,162	(703,922)
12	80,680	80,680	(623,241)
13	67,539	67,539	(555,703)
14	53,719	53,719	(501,984)
15	(684,947)	(684,947)	(1,186,931)
16	2,215,097	2,215,097	1,028,166
17	2,199,128	2,199,128	3,227,294
18	2,182,403	2,182,403	5,409,697
19	2,164,902	2,164,902	7,574,599
20	2,146,603	2,146,603	9,721,202

Southern and Eastern Interior
8% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Central Eastern Interior

Renewable energy delivered (MWh/yr): 43,700 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 19,743**



IRR and ROI: 7.9% **Year-to-positive cash flow: 15.5 yr** **Net Present Value: CAD -1,101,609**

Southern and Eastern Interior
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI	
Perform risk analysis too?	Yes	Sensitivity range	10%	
Project name		Threshold	0.0	%
Project location	Central Eastern Interior			

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
39,330	-10%	-1.8%	0.8%	3.4%	5.8%	8.3%
41,515	-5%	0.3%	3.0%	5.6%	8.2%	10.8%
43,700	0%	2.3%	5.2%	**7.9%**	10.7%	13.3%
45,885	5%	4.4%	7.4%	10.3%	13.1%	15.9%
48,070	10%	6.5%	9.6%	12.6%	15.6%	18.5%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
23,947,923	-10%	6.4%	9.5%	12.6%	15.6%	18.6%
25,278,364	-5%	4.2%	7.2%	10.1%	13.0%	15.8%
26,608,804	0%	2.3%	5.2%	**7.9%**	10.7%	13.3%
27,939,244	5%	0.6%	3.3%	6.0%	8.6%	11.1%
29,269,684	10%	-0.9%	1.7%	4.2%	6.7%	9.1%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0678	0.0716	**0.0754**	0.0791	0.0829
		-10%	-5%	0%	5%	10%
819,794	-10%	4.2%	7.0%	9.7%	12.4%	15.0%
865,338	-5%	3.3%	6.1%	8.8%	11.5%	14.2%
910,882	0%	2.3%	5.2%	**7.9%**	10.7%	13.3%
956,427	5%	1.3%	4.2%	7.0%	9.8%	12.5%
1,001,971	10%	0.3%	3.3%	6.1%	8.9%	11.6%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	8.8%	9.0%	9.3%	9.6%	10.1%
6.7%	-5%	8.3%	8.4%	8.6%	8.8%	9.1%
7.0%	0%	7.8%	7.9%	**7.9%**	8.0%	8.2%
7.4%	5%	7.3%	7.3%	7.3%	7.3%	7.2%
7.7%	10%	6.8%	6.7%	6.6%	6.5%	6.3%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.5%	9.4%	9.3%	10.2%	10.2%
6.7%	-5%	8.9%	8.8%	8.6%	9.5%	9.4%
7.0%	0%	8.4%	8.2%	**7.9%**	8.8%	8.6%
7.4%	5%	7.9%	7.6%	7.3%	8.1%	7.8%
7.7%	10%	7.3%	7.0%	6.6%	7.4%	7.0%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
39,330	-10%	3.0%	3.2%	3.4%	3.5%	3.7%
41,515	-5%	5.2%	5.4%	5.6%	5.9%	6.1%
43,700	0%	7.5%	7.7%	**7.9%**	8.2%	8.4%
45,885	5%	9.7%	10.0%	10.3%	10.5%	10.8%
48,070	10%	12.0%	12.3%	12.6%	12.9%	13.2%

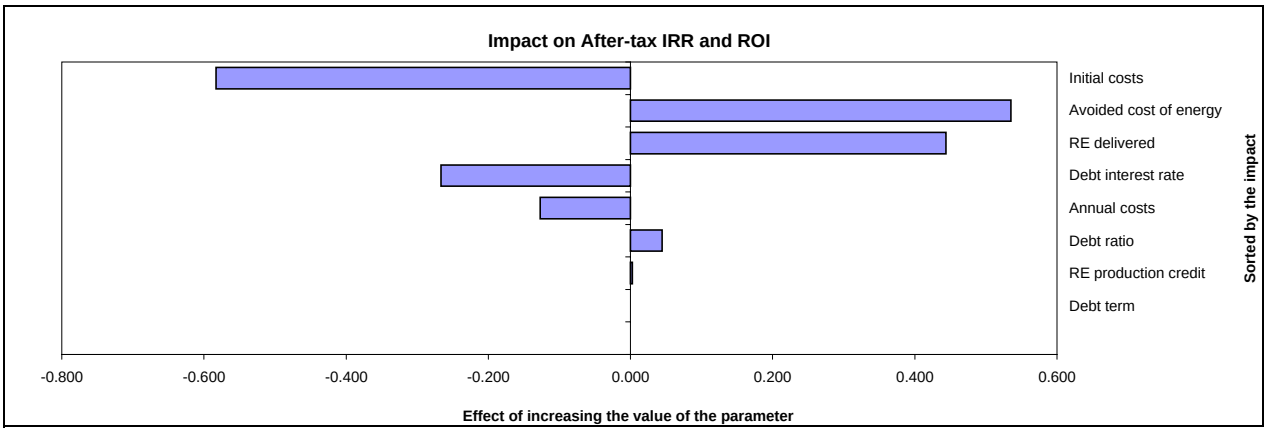
Southern and Eastern Interior
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

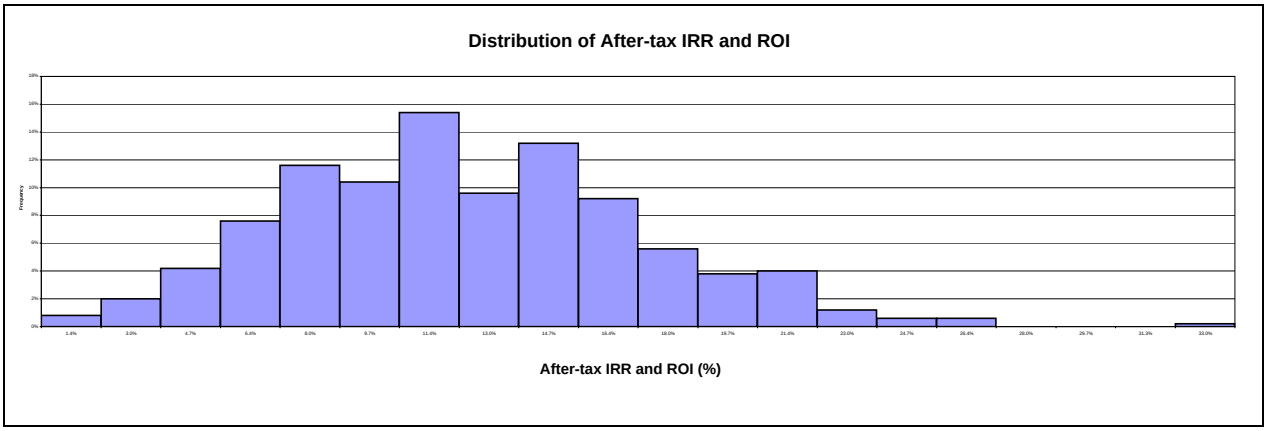
Risk Analysis for After-tax IRR and ROI

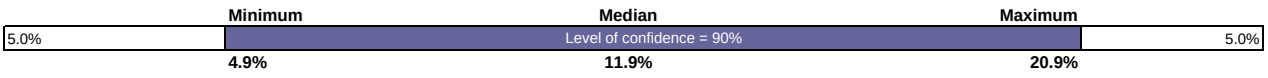
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0754	15%	0.0641	0.0867
RE delivered	MWh	43,700	15%	37,145	50,255
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	910,882	15%	774,250	1,047,515
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Southern and Eastern Interior
8% IRR
20 year lifetime of project

Southern and Eastern Interior Region

8% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Central Eastern Interior	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	10.3	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	7.1	
Average atmospheric pressure	kPa	88.0	60.0 to 103.0 kPa
Annual average temperature	°C	4	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	11.2	
Wind power density at hub height	W/m²	1,366	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	12,390	61,950	
Pressure adjustment coefficient	-	0.87	0.87	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	11,210	56,052	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,861	1,861	150 to 1,500 kWh/m²
Wind plant capacity factor	%	56%	56%	20% to 40%
Renewable energy delivered	MWh	9,829	**49,143**	
	kWh	9,828,652	49,143,261	
				Complete Cost Analysis sheet

Southern and Eastern Interior
8% IRR
40 year lifetime of project

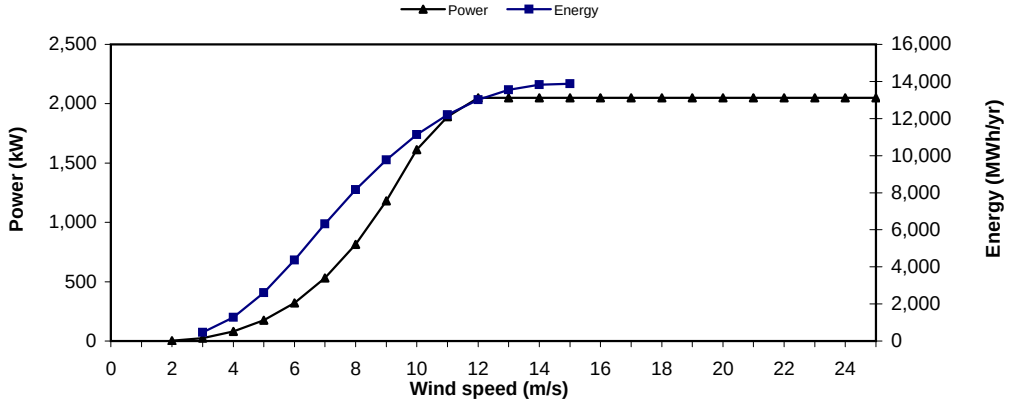
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Southern and Eastern Interior
8% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	49,143,261	CAD	0.003	CAD 122,858		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	211,908	CAD 19,072		-	-
Other - O&M	Cost	1	CAD	741,867	CAD 741,867		-	-
Contingencies	%	4%	CAD	972,847	CAD 38,914		-	-
Annual Costs - Total					**CAD 1,011,760**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		Go to GHG Analysis sheet

Southern and Eastern Interior
8% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Central Eastern Interior			
Renewable energy delivered	MWh	49,143	Net GHG reduction	t_{CO2}/yr	22,202
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	888,086

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0754	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	1,011,760
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,202,888**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,703,928
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	491,433
				Annual Savings - Total	**CAD**	**4,195,360**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	8.1%			
After-tax IRR and ROI	%	8.1%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8.4			
Year-to-positive cash flow	yr	6.9	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(723,167)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(73,951)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.89	Debt service coverage	-	1.44

Yearly Cash Flows

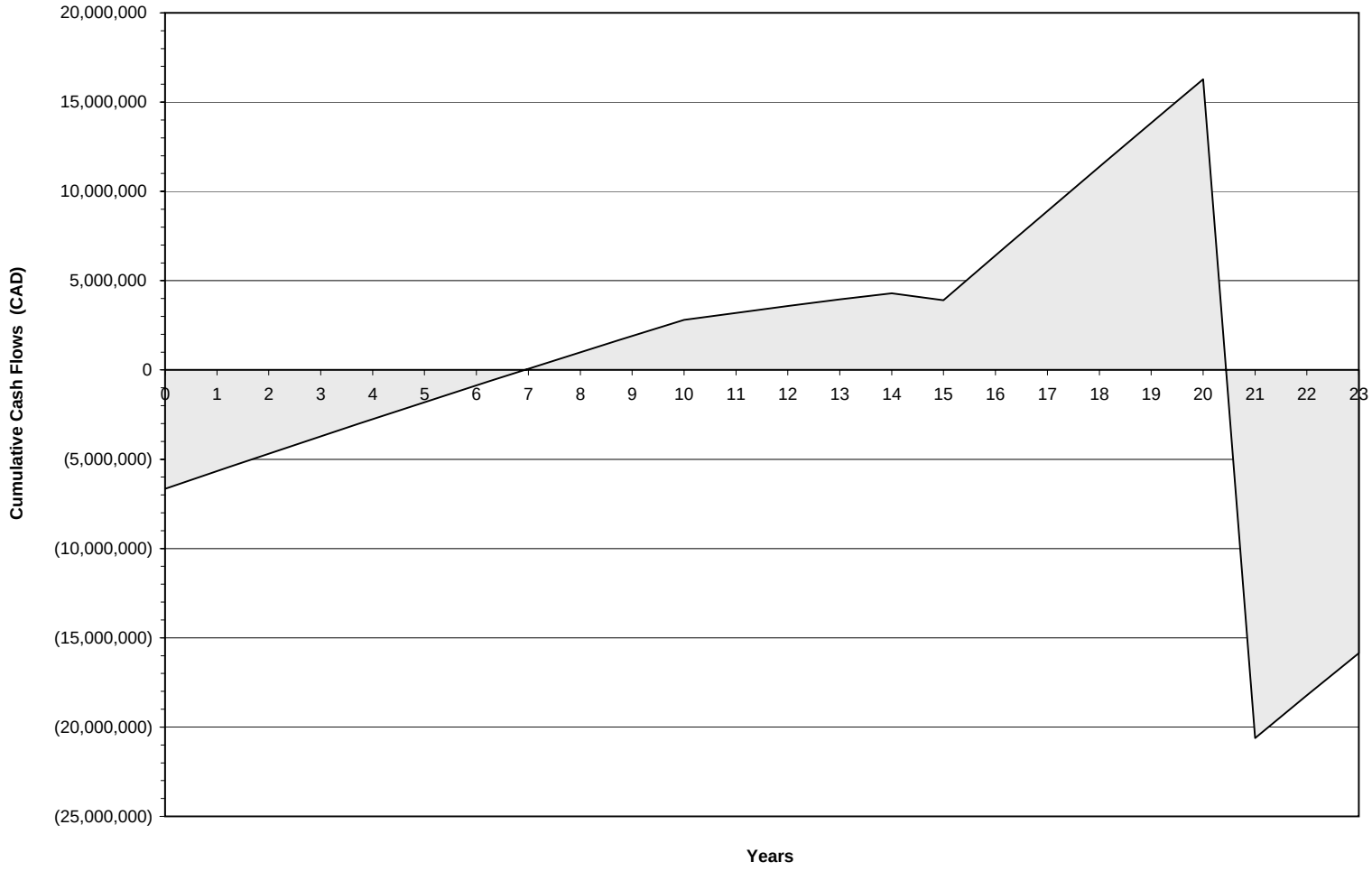
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	985,698	985,698	(5,666,503)
2	978,384	978,384	(4,688,120)
3	970,514	970,514	(3,717,605)
4	962,074	962,074	(2,755,531)
5	953,047	953,047	(1,802,484)
6	943,417	943,417	(859,067)
7	933,166	933,166	74,098
8	922,277	922,277	996,375
9	910,732	910,732	1,907,107
10	898,513	898,513	2,805,620
11	394,169	394,169	3,199,788
12	380,545	380,545	3,580,333
13	366,189	366,189	3,946,522
14	351,081	351,081	4,297,603
15	(388,949)	(388,949)	3,908,654
16	2,509,653	2,509,653	6,418,308
17	2,492,162	2,492,162	8,910,470
18	2,473,833	2,473,833	11,384,302
19	2,454,642	2,454,642	13,838,944
20	2,434,566	2,434,566	16,273,510
21	(36,888,634)	(36,888,634)	(20,615,124)
22	2,391,662	2,391,662	(18,223,462)
23	2,368,784	2,368,784	(15,854,678)
24	2,344,921	2,344,921	(13,509,757)
25	2,320,046	2,320,046	(11,189,712)
26	2,294,131	2,294,131	(8,895,581)
27	2,267,149	2,267,149	(6,628,432)
28	2,239,070	2,239,070	(4,389,362)
29	2,209,866	2,209,866	(2,179,496)
30	1,130,722	1,130,722	(1,048,774)
31	2,147,959	2,147,959	1,099,185
32	2,115,193	2,115,193	3,214,378
33	2,081,175	2,081,175	5,295,553
34	2,045,873	2,045,873	7,341,426
35	2,009,251	2,009,251	9,350,677
36	1,971,275	1,971,275	11,321,952
37	1,931,909	1,931,909	13,253,861
38	1,891,115	1,891,115	15,144,975
39	1,848,855	1,848,855	16,993,831
40	1,805,092	1,805,092	18,798,923

Southern and Eastern Interior
8% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Central Eastern Interior

Renewable energy delivered (MWh/yr): 49,143 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 22,202**



IRR and ROI: 8.1% **Year-to-positive cash flow: 6.9 yr** **Net Present Value: CAD -723,167**

Southern and Eastern Interior
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes
Perform risk analysis too?	Yes
Project name	
Project location	Central Eastern Interior

Perform analysis on	After-tax IRR and ROI
Sensitivity range	10%
Threshold	0.0 %

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh) 0.0678 -10%	0.0716 -5%	**0.0754 0%**	0.0791 5%	0.0829 10%
44,229	-10%	-1.7%	0.2%	2.4%	5.1%	8.5%
46,686	-5%	-0.4%	1.9%	4.7%	8.3%	12.4%
49,143	0%	1.1%	4.0%	**7.8%**	12.2%	16.3%
51,600	5%	2.9%	6.7%	11.5%	16.0%	19.9%
54,058	10%	5.3%	10.2%	15.2%	19.5%	23.2%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh) 0.0678 -10%	0.0716 -5%	**0.0754 0%**	0.0791 5%	0.0829 10%
23,947,923	-10%	3.2%	8.4%	14.4%	19.2%	23.2%
25,278,364	-5%	2.0%	5.6%	10.6%	15.5%	19.6%
26,608,804	0%	1.1%	4.0%	**7.8%**	12.2%	16.3%
27,939,244	5%	0.5%	2.9%	5.8%	9.5%	13.3%
29,269,684	10%	-0.1%	2.1%	4.5%	7.4%	10.8%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh) 0.0678 -10%	0.0716 -5%	**0.0754 0%**	0.0791 5%	0.0829 10%
910,584	-10%	3.2%	6.5%	10.6%	14.7%	18.5%
961,172	-5%	2.1%	5.2%	9.2%	13.5%	17.4%
1,011,760	0%	1.1%	4.0%	**7.8%**	12.2%	16.3%
1,062,348	5%	0.1%	2.8%	6.3%	10.8%	15.1%
1,112,936	10%	-0.8%	1.7%	5.0%	9.3%	13.8%

Debt interest rate (%)		Debt ratio (%) 67.5% -10%	71.3% -5%	**75.0% 0%**	78.8% 5%	82.5% 10%
6.3%	-10%	8.8%	9.1%	9.4%	9.9%	10.7%
6.7%	-5%	8.2%	8.4%	8.6%	8.8%	9.2%
7.0%	0%	7.6%	7.7%	**7.8%**	7.9%	8.0%
7.4%	5%	7.1%	7.1%	7.0%	7.0%	7.0%
7.7%	10%	6.6%	6.5%	6.4%	6.3%	6.1%

Debt interest rate (%)		Debt term (yr) 13.5 -10%	14.3 -5%	**15.0 0%**	15.8 5%	16.5 10%
6.3%	-10%	9.6%	9.5%	9.4%	10.6%	10.7%
6.7%	-5%	8.9%	8.7%	8.6%	9.7%	9.6%
7.0%	0%	8.3%	8.0%	**7.8%**	8.8%	8.5%
7.4%	5%	7.7%	7.4%	7.0%	7.9%	7.6%
7.7%	10%	7.2%	6.8%	6.4%	7.2%	6.8%

RE delivered (MWh)		RE production credit (CAD/kWh) 0.009 -10%	0.010 -5%	**0.010 0%**	0.011 5%	0.011 10%
44,229	-10%	2.3%	2.3%	2.4%	2.5%	2.6%
46,686	-5%	4.4%	4.6%	4.7%	4.9%	5.1%
49,143	0%	7.2%	7.5%	**7.8%**	8.0%	8.3%
51,600	5%	10.7%	11.1%	11.5%	11.8%	12.2%
54,058	10%	14.4%	14.8%	15.2%	15.6%	16.0%

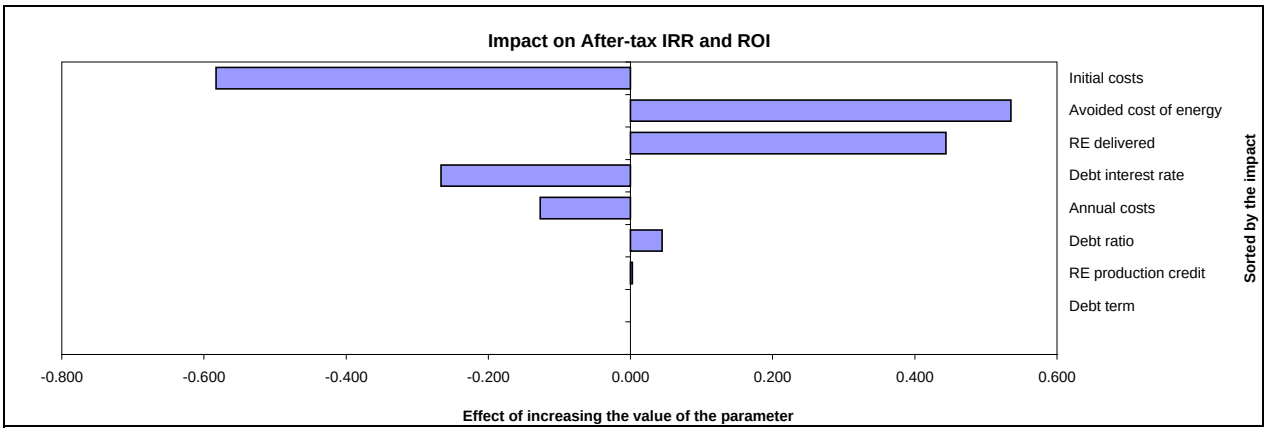
Southern and Eastern Interior
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

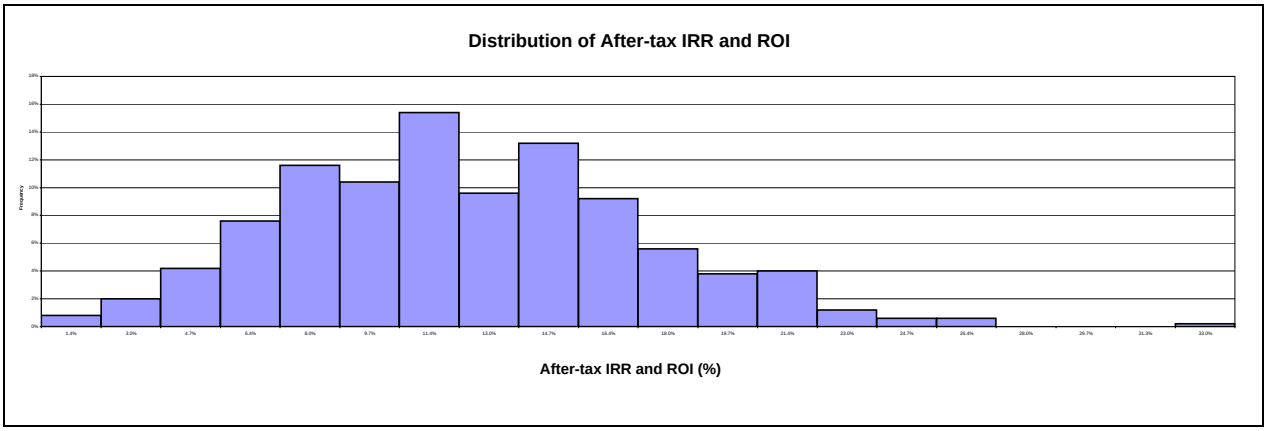
Risk Analysis for After-tax IRR and ROI

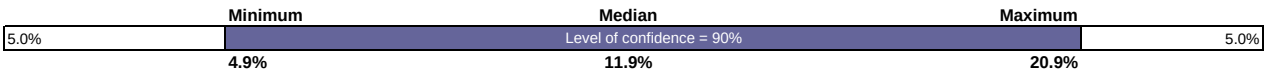
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0754	15%	0.0641	0.0867
RE delivered	MWh	49,143	15%	41,772	56,515
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	1,011,760	15%	859,996	1,163,524
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Southern and Eastern Interior
8% IRR
40 year lifetime of project

Vancouver Island

0% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Vancouver Island	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	6.7	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	4.6	
Average atmospheric pressure	kPa	98.0	60.0 to 103.0 kPa
Annual average temperature	°C	9	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	7.3	
Wind power density at hub height	W/m²	377	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	6,872	34,359	
Pressure adjustment coefficient	-	0.97	0.97	0.59 to 1.02
Temperature adjustment coefficient	-	1.02	1.02	0.98 to 1.15
Gross energy production	MWh	6,799	33,994	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,129	1,129	150 to 1,500 kWh/m²
Wind plant capacity factor	%	34%	34%	20% to 40%
Renewable energy delivered	MWh	5,961	**29,804**	
	kWh	5,960,838	29,804,188	

Complete Cost Analysis sheet

Vancouver Island
0% IRR
20 year lifetime of project

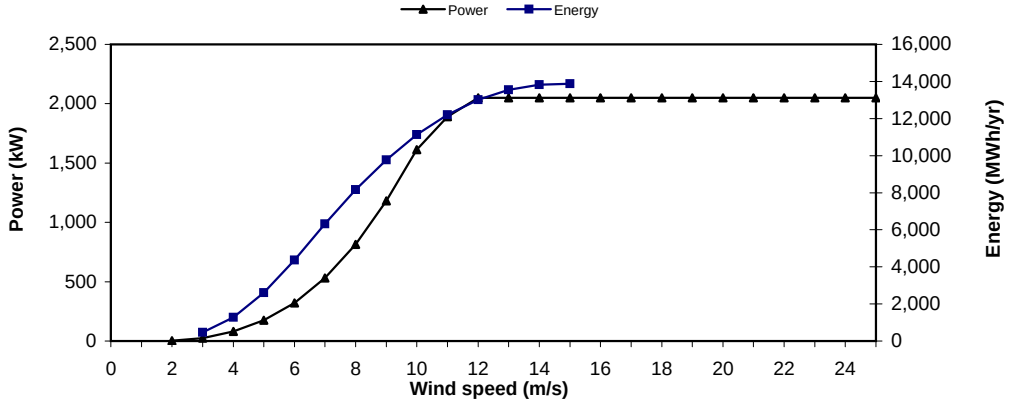
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Vancouver Island
0% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	29,804,188	CAD	0.003	CAD 74,510		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	163,560	CAD 14,720		-	-
Other - O&M	Cost	1	CAD	449,924	CAD 449,924		-	-
Contingencies	%	4%	CAD	628,205	CAD 25,128		-	-
Annual Costs - Total					**CAD 653,333**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Vancouver Island
0% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Vancouver Island			
Renewable energy delivered	MWh	29,804	Net GHG reduction	t_{CO2}/yr	13,465
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	269,301

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0873	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	653,333
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,844,461**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	2,602,800
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	298,042
				Annual Savings - Total	**CAD**	**2,900,842**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.4%			
After-tax IRR and ROI	%	0.4%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	11.8			
Year-to-positive cash flow	yr	19.7	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(5,401,517)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(634,460)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.19	Debt service coverage	-	0.52

Yearly Cash Flows

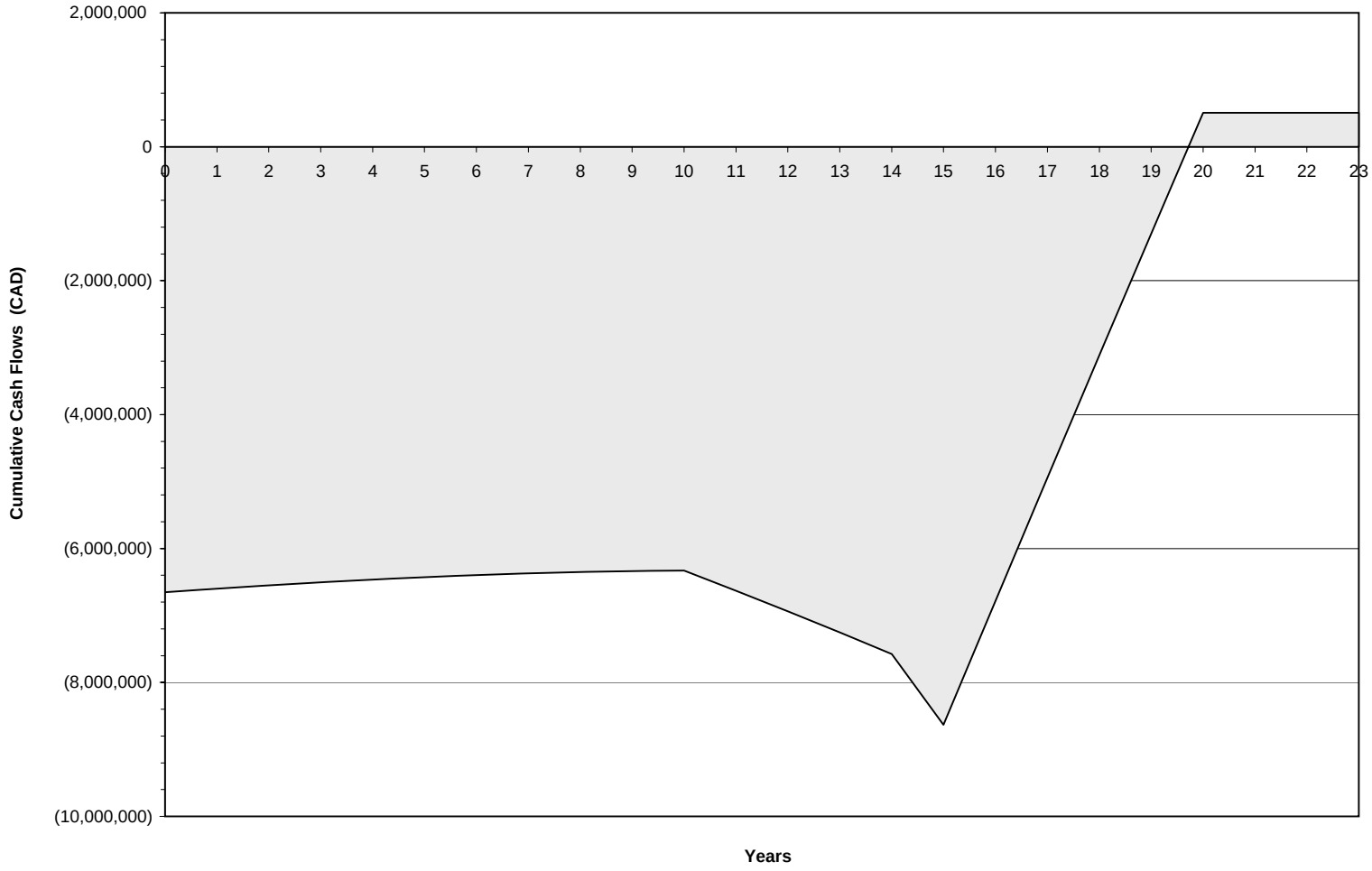
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	53,061	53,061	(6,599,140)
2	49,399	49,399	(6,549,741)
3	45,383	45,383	(6,504,358)
4	41,004	41,004	(6,463,354)
5	36,251	36,251	(6,427,102)
6	31,114	31,114	(6,395,988)
7	25,582	25,582	(6,370,406)
8	19,643	19,643	(6,350,763)
9	13,286	13,286	(6,337,476)
10	6,500	6,500	(6,330,976)
11	(298,771)	(298,771)	(6,629,747)
12	(306,453)	(306,453)	(6,936,201)
13	(314,603)	(314,603)	(7,250,804)
14	(323,233)	(323,233)	(7,574,037)
15	(1,056,506)	(1,056,506)	(8,630,543)
16	1,849,141	1,849,141	(6,781,402)
17	1,838,989	1,838,989	(4,942,413)
18	1,828,301	1,828,301	(3,114,112)
19	1,817,063	1,817,063	(1,297,049)
20	1,805,259	1,805,259	508,211

Vancouver Island
0% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Vancouver Island

Renewable energy delivered (MWh/yr): 29,804 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 13,465**



IRR and ROI: 0.4% **Year-to-positive cash flow: 19.7 yr** **Net Present Value: CAD -5,401,517**

Vancouver Island
0% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Vancouver Island		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
26,824	-10%	-7.2%	-5.1%	-3.1%	-1.2%	0.7%
28,314	-5%	-5.6%	-3.4%	-1.4%	0.6%	2.6%
29,804	0%	-4.0%	-1.8%	**0.4%**	2.5%	4.6%
31,294	5%	-2.4%	-0.1%	2.2%	4.3%	6.5%
32,785	10%	-0.8%	1.6%	3.9%	6.2%	8.5%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-0.9%	1.5%	3.9%	6.2%	8.5%
25,278,364	-5%	-2.5%	-0.2%	2.0%	4.2%	6.4%
26,608,804	0%	-4.0%	-1.8%	**0.4%**	2.5%	4.6%
27,939,244	5%	-5.3%	-3.1%	-1.1%	0.9%	2.9%
29,269,684	10%	-6.5%	-4.4%	-2.4%	-0.5%	1.4%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
588,000	-10%	-2.6%	-0.4%	1.7%	3.7%	5.8%
620,666	-5%	-3.3%	-1.1%	1.0%	3.1%	5.2%
653,333	0%	-4.0%	-1.8%	**0.4%**	2.5%	4.6%
686,000	5%	-4.7%	-2.4%	-0.3%	1.8%	3.9%
718,666	10%	-5.4%	-3.2%	-0.9%	1.2%	3.3%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	2.2%	1.9%	1.5%	1.2%	0.7%
6.7%	-5%	1.7%	1.4%	1.0%	0.5%	0.0%
7.0%	0%	1.3%	0.8%	**0.4%**	-0.1%	-0.7%
7.4%	5%	0.8%	0.3%	-0.2%	-0.7%	-1.3%
7.7%	10%	0.3%	-0.2%	-0.7%	-1.3%	-2.0%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	2.8%	2.2%	1.5%	2.3%	1.5%
6.7%	-5%	2.4%	1.7%	1.0%	1.7%	0.8%
7.0%	0%	2.0%	1.2%	**0.4%**	1.1%	0.1%
7.4%	5%	1.6%	0.8%	-0.2%	0.5%	-0.6%
7.7%	10%	1.1%	0.3%	-0.7%	-0.1%	-1.3%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
26,824	-10%	-3.3%	-3.2%	-3.1%	-3.1%	-3.0%
28,314	-5%	-1.6%	-1.5%	-1.4%	-1.3%	-1.2%
29,804	0%	0.2%	0.3%	**0.4%**	0.5%	0.6%
31,294	5%	1.9%	2.0%	2.2%	2.3%	2.4%
32,785	10%	3.6%	3.8%	3.9%	4.1%	4.2%

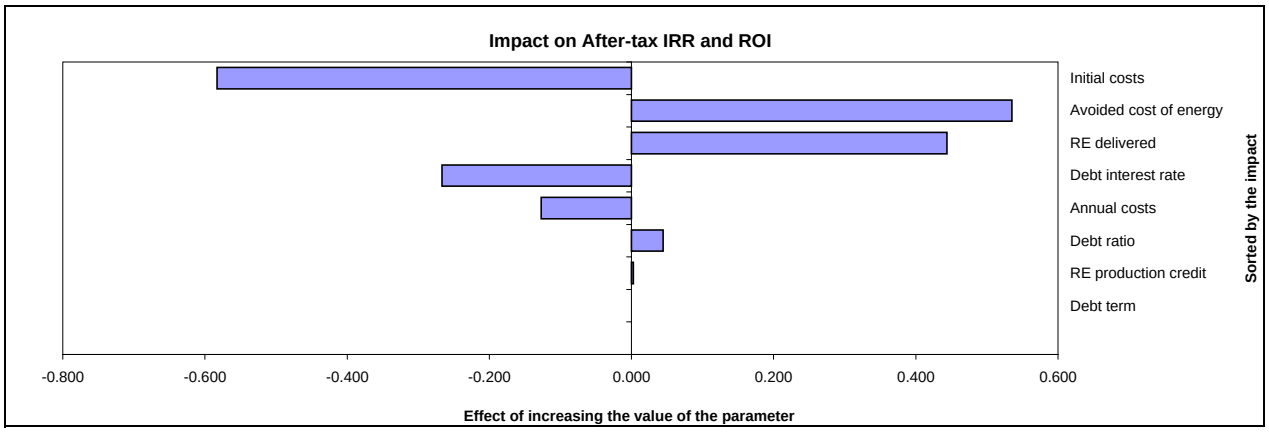
Vancouver Island
0% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

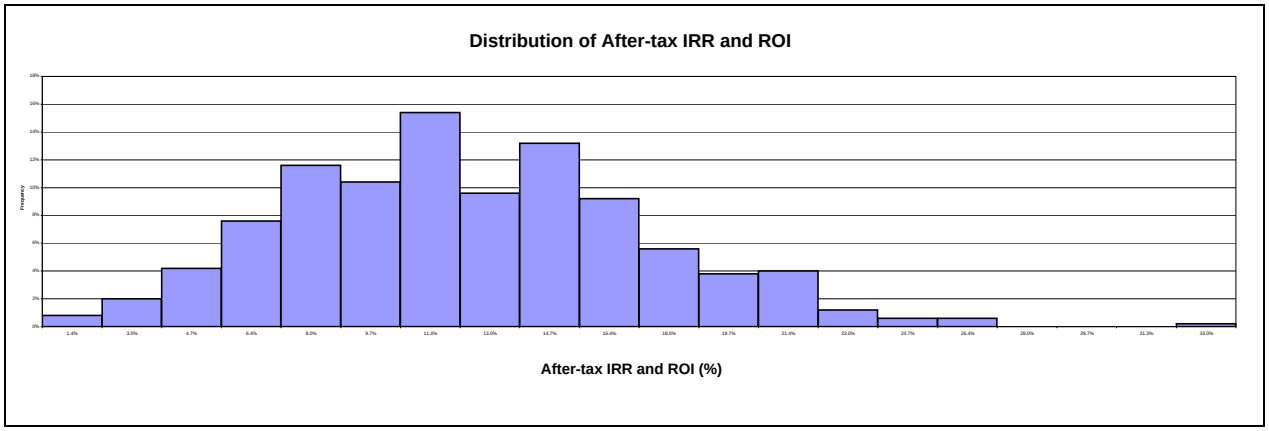
Risk Analysis for After-tax IRR and ROI

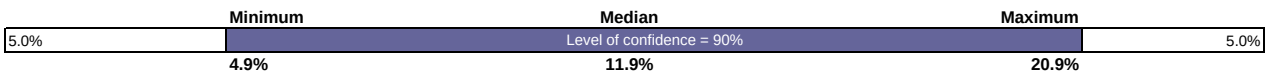
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0873	15%	0.0742	0.1004
RE delivered	MWh	29,804	15%	25,334	34,275
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	653,333	15%	555,333	751,333
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Vancouver Island
0% IRR
20 year lifetime of project

Vancouver Island

0% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Vancouver Island	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	7.1	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	4.9	
Average atmospheric pressure	kPa	98.0	60.0 to 103.0 kPa
Annual average temperature	°C	9	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	7.7	
Wind power density at hub height	W/m²	449	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	7,677	38,384	
Pressure adjustment coefficient	-	0.97	0.97	0.59 to 1.02
Temperature adjustment coefficient	-	1.02	1.02	0.98 to 1.15
Gross energy production	MWh	7,596	37,978	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,261	1,261	150 to 1,500 kWh/m²
Wind plant capacity factor	%	38%	38%	20% to 40%
Renewable energy delivered	MWh	6,659	**33,296**	
	kWh	6,659,276	33,296,381	
				Complete Cost Analysis sheet

Vancouver Island
0% IRR
40 year lifetime of project

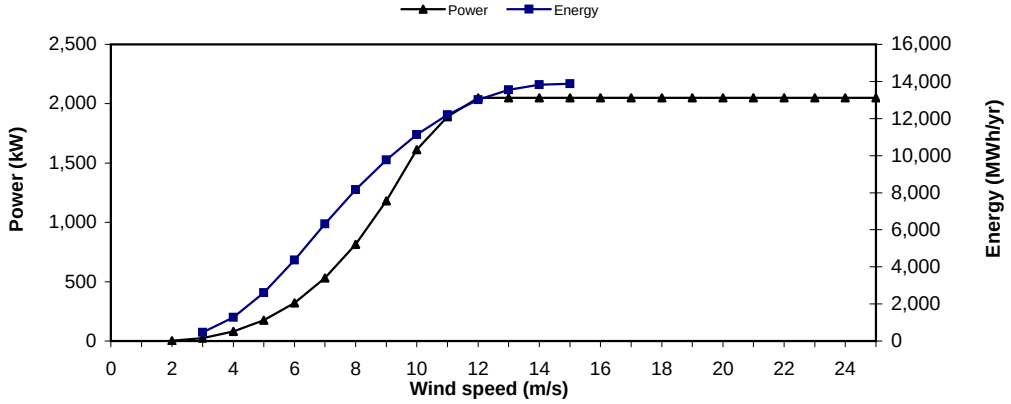
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Vancouver Island
0% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	33,296,381	CAD	0.003	CAD 83,241		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	172,291	CAD 15,506		-	-
Other - O&M	Cost	1	CAD	502,642	CAD 502,642		-	-
Contingencies	%	4%	CAD	690,439	CAD 27,618		-	-
Annual Costs - Total					**CAD 718,057**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Vancouver Island
0% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Vancouver Island			
Renewable energy delivered	MWh	33,296	Net GHG reduction	t_{CO2}/yr	15,043
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	601,711

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0873	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	718,057
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,909,185**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	2,907,773
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	332,964
				Annual Savings - Total	**CAD**	**3,240,737**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	0.6%			
After-tax IRR and ROI	%	0.6%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	10.5			
Year-to-positive cash flow	yr	17.3	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(6,116,368)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(625,456)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.08	Debt service coverage	-	0.89

Yearly Cash Flows

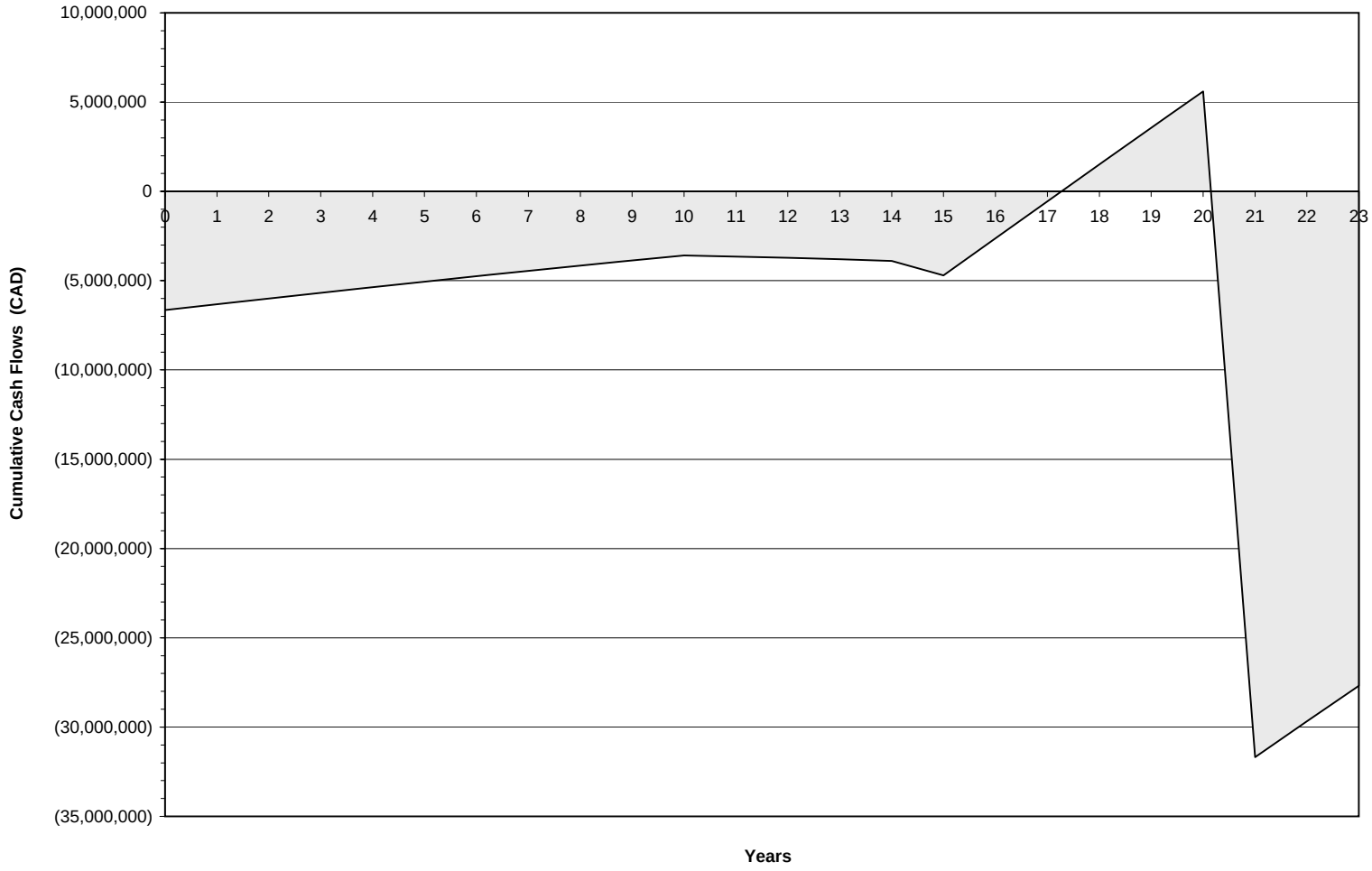
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	328,140	328,140	(6,324,061)
2	324,351	324,351	(5,999,710)
3	320,175	320,175	(5,679,535)
4	315,602	315,602	(5,363,933)
5	310,619	310,619	(5,053,315)
6	305,214	305,214	(4,748,100)
7	299,377	299,377	(4,448,724)
8	293,093	293,093	(4,155,631)
9	286,352	286,352	(3,869,279)
10	279,139	279,139	(3,590,139)
11	(61,521)	(61,521)	(3,651,661)
12	(69,716)	(69,716)	(3,721,377)
13	(78,423)	(78,423)	(3,799,800)
14	(87,657)	(87,657)	(3,887,457)
15	(821,581)	(821,581)	(4,709,038)
16	2,083,366	2,083,366	(2,625,672)
17	2,072,463	2,072,463	(553,209)
18	2,060,973	2,060,973	1,507,764
19	2,048,880	2,048,880	3,556,644
20	2,036,166	2,036,166	5,592,810
21	(37,279,401)	(37,279,401)	(31,686,591)
22	2,008,807	2,008,807	(29,677,784)
23	1,994,128	1,994,128	(27,683,656)
24	1,978,757	1,978,757	(25,704,899)
25	1,962,675	1,962,675	(23,742,224)
26	1,945,864	1,945,864	(21,796,361)
27	1,928,303	1,928,303	(19,868,058)
28	1,909,972	1,909,972	(17,958,087)
29	1,890,849	1,890,849	(16,067,237)
30	822,131	822,131	(15,245,106)
31	1,850,146	1,850,146	(13,394,960)
32	1,828,520	1,828,520	(11,566,440)
33	1,806,014	1,806,014	(9,760,425)
34	1,782,605	1,782,605	(7,977,820)
35	1,758,267	1,758,267	(6,219,553)
36	1,732,977	1,732,977	(4,486,577)
37	1,706,707	1,706,707	(2,779,869)
38	1,679,434	1,679,434	(1,100,436)
39	1,651,128	1,651,128	550,693
40	1,621,764	1,621,764	2,172,457

Vancouver Island
0% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Vancouver Island

Renewable energy delivered (MWh/yr): 33,296 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 15,043**



IRR and ROI: 0.6% **Year-to-positive cash flow: 17.3 yr** **Net Present Value: CAD -6,116,368**

Vancouver Island
0% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Vancouver Island		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
29,967	-10%	-4.4%	-3.1%	-1.8%	-0.4%	1.0%
31,632	-5%	-3.5%	-2.1%	-0.6%	0.9%	2.6%
33,296	0%	-2.6%	-1.1%	**0.6%**	2.3%	4.4%
34,961	5%	-1.6%	0.1%	1.9%	4.1%	6.7%
36,626	10%	-0.6%	1.3%	3.5%	6.2%	9.4%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
23,947,923	-10%	-1.9%	-0.1%	2.0%	4.5%	7.9%
25,278,364	-5%	-2.3%	-0.6%	1.2%	3.3%	5.8%
26,608,804	0%	-2.6%	-1.1%	**0.6%**	2.3%	4.4%
27,939,244	5%	-2.9%	-1.4%	0.0%	1.6%	3.4%
29,269,684	10%	-3.1%	-1.8%	-0.4%	1.1%	2.6%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
646,251	-10%	-1.4%	0.2%	1.8%	3.8%	6.0%
682,154	-5%	-2.0%	-0.4%	1.2%	3.0%	5.2%
718,057	0%	-2.6%	-1.1%	**0.6%**	2.3%	4.4%
753,960	5%	-3.2%	-1.7%	-0.1%	1.7%	3.6%
789,863	10%	-3.8%	-2.3%	-0.7%	1.0%	2.9%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.3%	1.1%	1.0%	0.8%	0.7%
6.7%	-5%	1.1%	0.9%	0.8%	0.6%	0.4%
7.0%	0%	0.9%	0.7%	**0.6%**	0.4%	0.2%
7.4%	5%	0.7%	0.5%	0.4%	0.2%	0.0%
7.7%	10%	0.5%	0.3%	0.2%	0.0%	-0.2%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	1.6%	1.3%	1.0%	1.3%	1.0%
6.7%	-5%	1.4%	1.1%	0.8%	1.1%	0.7%
7.0%	0%	1.2%	0.9%	**0.6%**	0.8%	0.5%
7.4%	5%	1.0%	0.7%	0.4%	0.6%	0.3%
7.7%	10%	0.9%	0.5%	0.2%	0.4%	0.1%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
29,967	-10%	-1.8%	-1.8%	-1.8%	-1.7%	-1.7%
31,632	-5%	-0.7%	-0.7%	-0.6%	-0.6%	-0.6%
33,296	0%	0.5%	0.5%	**0.6%**	0.6%	0.7%
34,961	5%	1.8%	1.8%	1.9%	2.0%	2.0%
36,626	10%	3.3%	3.4%	3.5%	3.6%	3.7%

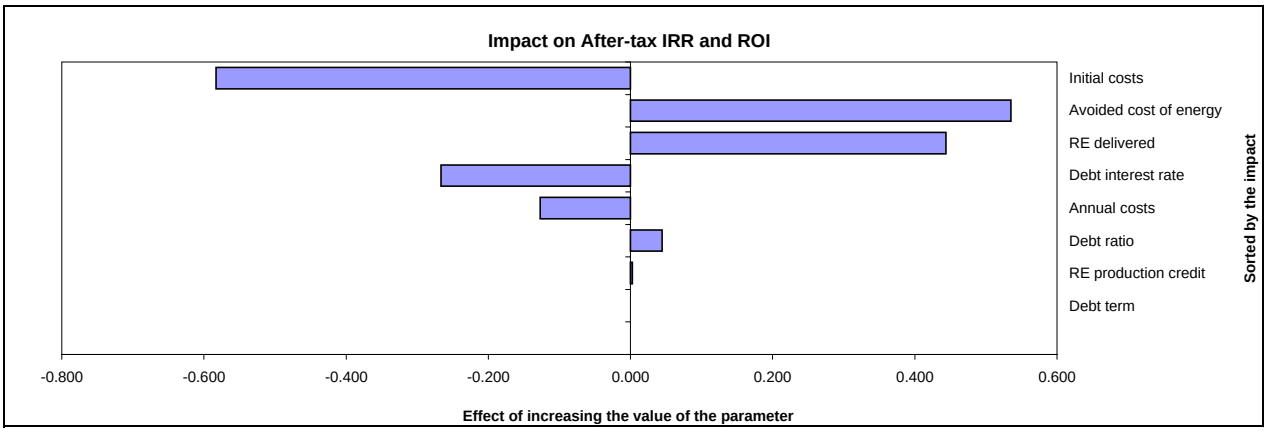
Vancouver Island
0% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

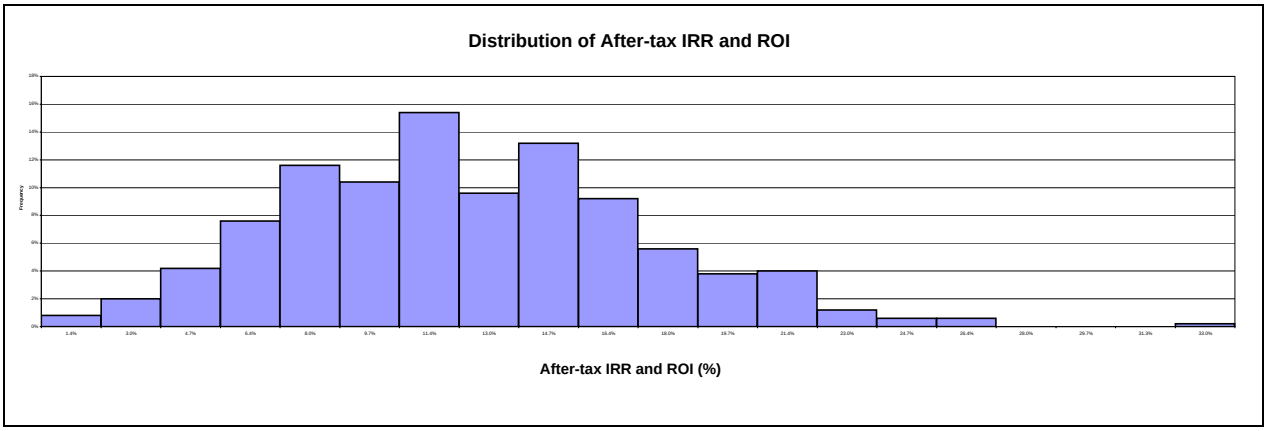
Risk Analysis for After-tax IRR and ROI

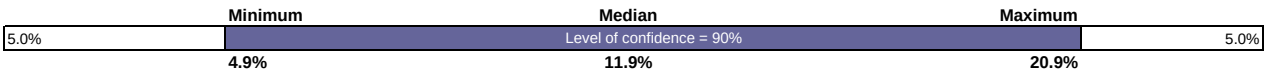
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0873	15%	0.0742	0.1004
RE delivered	MWh	33,296	15%	28,302	38,291
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	718,057	15%	610,348	825,765
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Vancouver Island
0% IRR
40 year lifetime of project

Vancouver Island

8% IRR

20 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Vancouver Island	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	7.5	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.2	
Average atmospheric pressure	kPa	98.0	60.0 to 103.0 kPa
Annual average temperature	°C	9	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.2	
Wind power density at hub height	W/m²	529	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	8,442	42,211	
Pressure adjustment coefficient	-	0.97	0.97	0.59 to 1.02
Temperature adjustment coefficient	-	1.02	1.02	0.98 to 1.15
Gross energy production	MWh	8,353	41,763	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,387	1,387	150 to 1,500 kWh/m²
Wind plant capacity factor	%	42%	42%	20% to 40%
Renewable energy delivered	MWh	7,323	**36,615**	
	kWh	7,323,078	36,615,388	
				Complete Cost Analysis sheet

Vancouver Island
8% IRR
20 year lifetime of project

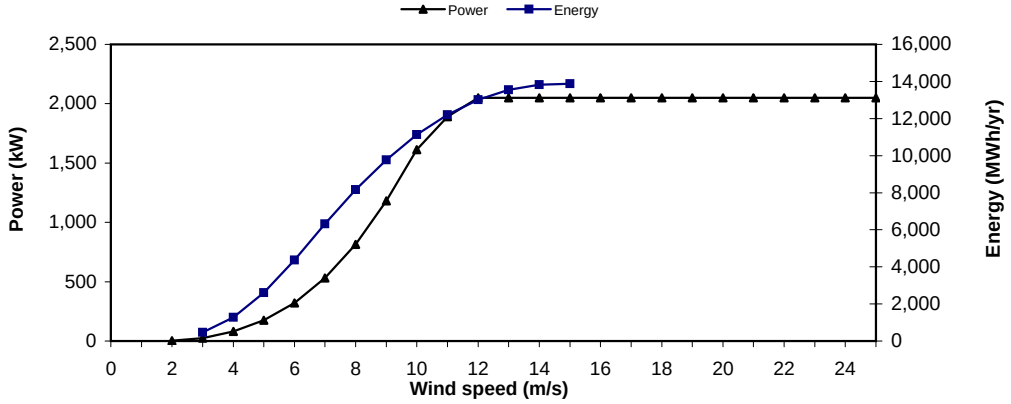
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Vancouver Island
8% IRR
20 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	36,615,388	CAD	0.003	CAD 91,538		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	180,588	CAD 16,253		-	-
Other - O&M	Cost	1	CAD	552,746	CAD 552,746		-	-
Contingencies	%	4%	CAD	749,587	CAD 29,983		-	-
Annual Costs - Total					**CAD 779,571**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Vancouver Island
8% IRR
20 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Vancouver Island			
Renewable energy delivered	MWh	36,615	Net GHG reduction	t_{CO2}/yr	16,542
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	330,845

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0873	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	779,571
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**2,970,699**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,197,622
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	366,154
				Annual Savings - Total	**CAD**	**3,563,776**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr #	15	
Turbine Replacement		CAD	23,400,000	Schedule yr #		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	8.1%			
After-tax IRR and ROI	%	8.1%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	9.6			
Year-to-positive cash flow	yr	15.4	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(1,028,905)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(120,855)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.85	Debt service coverage	-	1.26

Yearly Cash Flows

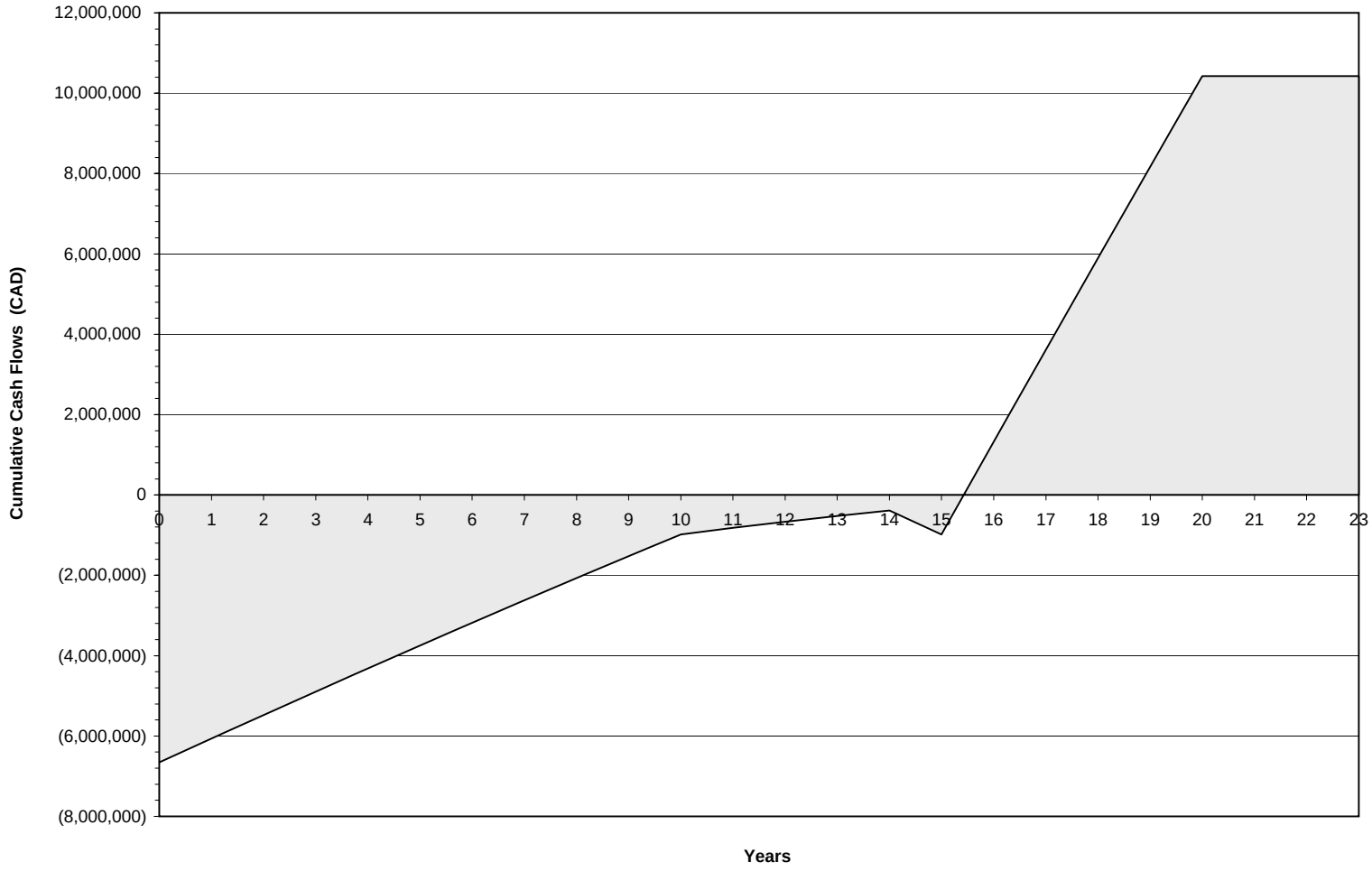
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	589,576	589,576	(6,062,625)
2	585,668	585,668	(5,476,957)
3	581,340	581,340	(4,895,617)
4	576,581	576,581	(4,319,036)
5	571,379	571,379	(3,747,657)
6	565,721	565,721	(3,181,936)
7	559,593	559,593	(2,622,344)
8	552,982	552,982	(2,069,361)
9	545,876	545,876	(1,523,486)
10	538,258	538,258	(985,228)
11	163,962	163,962	(821,265)
12	155,280	155,280	(665,985)
13	146,044	146,044	(519,941)
14	136,237	136,237	(383,705)
15	(598,306)	(598,306)	(982,011)
16	2,305,975	2,305,975	1,323,964
17	2,294,359	2,294,359	3,618,323
18	2,282,107	2,282,107	5,900,429
19	2,269,200	2,269,200	8,169,629
20	2,255,621	2,255,621	10,425,250

Vancouver Island
8% IRR
20 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Vancouver Island

Renewable energy delivered (MWh/yr): 36,615 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 16,542**



IRR and ROI: 8.1% **Year-to-positive cash flow: 15.4 yr** **Net Present Value: CAD -1,028,905**

Vancouver Island
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Vancouver Island		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
32,954	-10%	-1.0%	1.4%	3.8%	6.1%	8.3%
34,785	-5%	1.0%	3.5%	5.9%	8.4%	10.8%
36,615	0%	2.9%	5.6%	**8.1%**	10.7%	13.2%
38,446	5%	4.9%	7.7%	10.4%	13.0%	15.7%
40,277	10%	6.9%	9.8%	12.6%	15.4%	18.2%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
23,947,923	-10%	6.9%	9.8%	12.6%	15.5%	18.3%
25,278,364	-5%	4.8%	7.5%	10.3%	12.9%	15.6%
26,608,804	0%	2.9%	5.6%	**8.1%**	10.7%	13.2%
27,939,244	5%	1.3%	3.8%	6.3%	8.7%	11.1%
29,269,684	10%	-0.2%	2.2%	4.6%	6.9%	9.1%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
701,614	-10%	4.5%	7.1%	9.6%	12.1%	14.6%
740,592	-5%	3.7%	6.3%	8.9%	11.4%	13.9%
779,571	0%	2.9%	5.6%	**8.1%**	10.7%	13.2%
818,549	5%	2.1%	4.8%	7.4%	10.0%	12.5%
857,528	10%	1.3%	4.0%	6.7%	9.2%	11.8%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	8.9%	9.2%	9.5%	9.8%	10.2%
6.7%	-5%	8.5%	8.6%	8.8%	9.0%	9.3%
7.0%	0%	8.0%	8.0%	**8.1%**	8.3%	8.4%
7.4%	5%	7.5%	7.5%	7.5%	7.5%	7.5%
7.7%	10%	7.0%	6.9%	6.9%	6.8%	6.7%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.6%	9.5%	9.5%	10.3%	10.3%
6.7%	-5%	9.1%	8.9%	8.8%	9.6%	9.5%
7.0%	0%	8.5%	8.3%	**8.1%**	9.0%	8.8%
7.4%	5%	8.0%	7.8%	7.5%	8.3%	8.0%
7.7%	10%	7.5%	7.2%	6.9%	7.6%	7.3%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
32,954	-10%	3.5%	3.6%	3.8%	3.9%	4.1%
34,785	-5%	5.6%	5.8%	5.9%	6.1%	6.3%
36,615	0%	7.8%	8.0%	**8.1%**	8.3%	8.5%
38,446	5%	9.9%	10.1%	10.4%	10.6%	10.8%
40,277	10%	12.1%	12.4%	12.6%	12.8%	13.1%

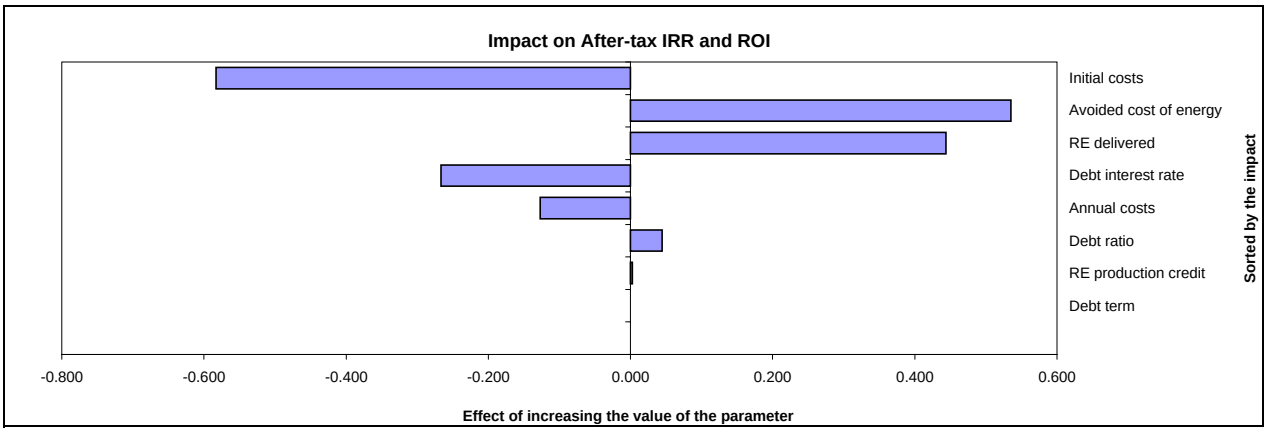
Vancouver Island
8% IRR
20 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

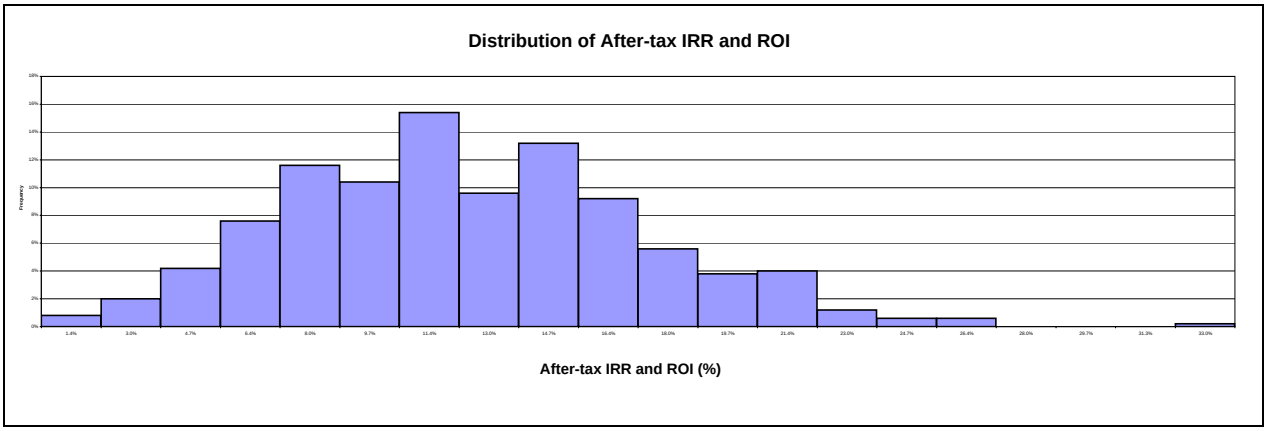
Risk Analysis for After-tax IRR and ROI

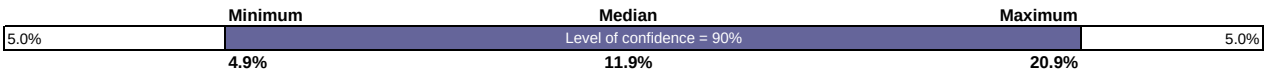
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0873	15%	0.0742	0.1004
RE delivered	MWh	36,615	15%	31,123	42,108
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	779,571	15%	662,635	896,506
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Vancouver Island
8% IRR
20 year lifetime of project

Vancouver Island

8% IRR

40 Year Lifetime of Project

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name			See Online Manual
Project location		Vancouver Island	
Wind data source		Wind speed	
Nearest location for weather data			See Weather Database
Annual average wind speed	m/s	8.0	
Height of wind measurement	m	65.0	3.0 to 100.0 m
Wind shear exponent	-	0.20	0.10 to 0.40
Wind speed at 10 m	m/s	5.5	
Average atmospheric pressure	kPa	98.0	60.0 to 103.0 kPa
Annual average temperature	°C	9	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2000	Complete Equipment Data sheet
Number of turbines	-	5	
Wind plant capacity	kW	10,000	
Hub height	m	100.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.7	
Wind power density at hub height	W/m²	642	
Array losses	%	5%	0% to 20%
Airfoil soiling and/or icing losses	%	2%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	4%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,000	10,000	
	MW	2.000	10.000	
Unadjusted energy production	MWh	9,324	46,620	
Pressure adjustment coefficient	-	0.97	0.97	0.59 to 1.02
Temperature adjustment coefficient	-	1.02	1.02	0.98 to 1.15
Gross energy production	MWh	9,225	46,126	
Losses coefficient	-	0.88	0.88	0.75 to 1.00
Specific yield	kWh/m²	1,532	1,532	150 to 1,500 kWh/m²
Wind plant capacity factor	%	46%	46%	20% to 40%
Renewable energy delivered	MWh	8,088	**40,441**	
	kWh	8,088,151	40,440,754	
				Complete Cost Analysis sheet

Vancouver Island
8% IRR
40 year lifetime of project

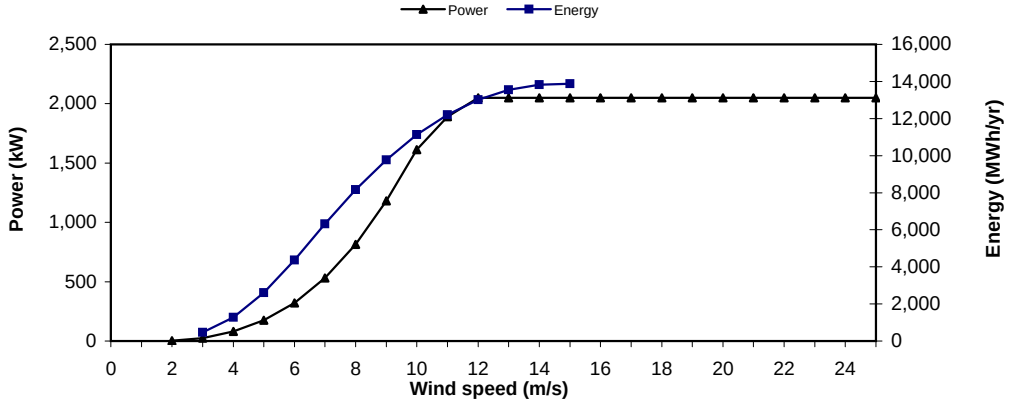
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2000	See Product Database
Hub height	m	100.0	6.0 to 100.0 m
Rotor diameter	m	82	7 to 80 m
Swept area	m²	5,281	35 to 5,027 m²
Wind turbine manufacturer		Enercon	
Wind turbine model		Enercon E82	
Energy curve data source	-	Custom	Weibull wind distribution
Shape factor	-	2.5	1.0 to 3.0

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	-	-
1	-	-
2	3.0	-
3	25.0	472.6
4	82.0	1,271.2
5	174.0	2,600.3
6	321.0	4,373.2
7	532.0	6,312.4
8	815.0	8,159.2
9	1,180.0	9,777.5
10	1,612.0	11,127.3
11	1,890.0	12,206.5
12	2,050.0	13,015.8
13	2,050.0	13,555.3
14	2,050.0	13,833.2
15	2,050.0	13,872.0
16	2,050.0	-
17	2,050.0	-
18	2,050.0	-
19	2,050.0	-
20	2,050.0	-
21	2,050.0	-
22	2,050.0	-
23	2,050.0	-
24	2,050.0	-
25	2,050.0	-

Power and Energy Curves



Return to Energy Model sheet

Vancouver Island
8% IRR
40 year lifetime of project

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Feasibility | Currency: Canada | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Site investigation	p-d	1.0	CAD	8,000	CAD 8,000		-	-
Wind resource assessment	met tower	1.0	CAD	55,000	CAD 55,000		-	-
Environmental assessment	p-d	1.0	CAD	160,000	CAD 160,000		-	-
Preliminary design	p-d	1.0	$	25,000	CAD 25,000		-	-
Detailed cost estimate	p-d	1.0	$	21,000	CAD 21,000		-	-
GHG baseline study and MP	project	0	CAD	-	CAD -		-	-
Report preparation	p-d	0.0	CAD	-	CAD -		-	-
Project management	p-d	1.0	$	10,000	CAD 10,000		-	-
Travel and accommodation	p-trip	0	$	-	CAD -		-	-
Other - Feasibility study	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 279,000**	1.0%		
Development								
PPA negotiation	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Permits and approvals	p-d	1.0	CAD	80,000	CAD 80,000		-	-
Land rights	project	0	CAD	-	CAD -		-	-
Land survey	p-d	1.0	CAD	6,000	CAD 6,000		-	-
GHG validation and registration	project	0	CAD	-	CAD -		-	-
Project financing	p-d	1.0	CAD	6,000	CAD 6,000		-	-
Legal and accounting	p-d	10.0	CAD	1,200	CAD 12,000		-	-
Project management	p-yr	1.00	CAD	45,000	CAD 45,000		-	-
Travel and accommodation	p-trip	1	CAD	10,000	CAD 10,000		-	-
Other - Development	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 174,000**	0.7%		
Engineering								
Wind turbine(s) micro-siting	p-d	1.0	CAD	5,000	CAD 5,000		-	-
Mechanical design	p-d	1.0	CAD	-	CAD -		-	-
Electrical design	p-d	1.0	CAD	100,000	CAD 100,000		-	-
Civil design	p-d	1.0	CAD	25,000	CAD 25,000		-	-
Tenders and contracting	p-d	1.0	CAD	15,000	CAD 15,000		-	-
Construction supervision	p-yr	1.00	CAD	90,000	CAD 90,000		-	-
Other - Engineering	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 235,000**	0.9%		
Energy Equipment								
Wind turbine(s)	kW	10,000	CAD	2,340	CAD 23,400,000		-	-
Spare parts	%	0.0%	CAD	23,400,000	CAD -		-	-
Transportation	turbine	5			CAD -		-	-
Other - Energy equipment	Cost	0	CAD	-	CAD -		-	-
Sub-total:					**CAD 23,400,000**	87.9%		
Balance of Plant								
Wind turbine(s) foundation(s)	turbine	5	CAD	-	CAD -		-	-
Wind turbine(s) erection	turbine	5	CAD	-	CAD -		-	-
Road construction	km	6.00	CAD	40,000	CAD 240,000		-	-
Transmission line	km	5.00	CAD	145,000	CAD 725,000		-	-
Substation	project	1	CAD	180,000	CAD 180,000		-	-
Control and O&M building(s)	building	0	CAD	-	CAD -		-	-
Transportation	project	0	CAD	-	CAD -		-	-
HONI Costs	Cost	1	CAD	500,000	CAD 500,000		-	-
Sub-total:					**CAD 1,645,000**	6.2%		
Miscellaneous								
Training	p-d	15.0	CAD	800	CAD 12,000		-	-
Commissioning	p-d	25.0	CAD	800	CAD 20,000		-	-
Contingencies	%	2%	CAD	25,765,000	CAD 515,300		-	-
Interest during construction	6.0%	5 month(s)	CAD	26,280,300	CAD 328,504		-	-
Sub-total:					**CAD 875,804**	3.3%		
Initial Costs - Total					**CAD 26,608,804**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Land lease	project	1	CAD	5,000	CAD 5,000		-	-
Property taxes	project	1	CAD	22,000	CAD 22,000		-	-
Insurance premium	project	5	CAD	10,000	CAD 50,000		-	-
Transmission line maintenance	%	1.0%	CAD	905,000	CAD 9,050		-	-
Parts and labour	kWh	40,440,754	CAD	0.003	CAD 101,102		-	-
GHG monitoring and verification	project				CAD -		-	-
Community benefits	project	1			CAD -		-	-
Travel and accommodation	p-trip	1	CAD	3,000	CAD 3,000		-	-
General and administrative	%	9%	CAD	190,152	CAD 17,114		-	-
Other - O&M	Cost	1	CAD	610,494	CAD 610,494		-	-
Contingencies	%	4%	CAD	817,759	CAD 32,710		-	-
Annual Costs - Total					**CAD 850,470**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Repair	Cost	15 yr	CAD	500,000	**CAD 500,000**	-	-
Turbine Replacement	Cost	21 yr	CAD	23,400,000	**CAD 23,400,000**	-	-
					CAD -	-	-
End of project life	Credit	-	CAD	-	**CAD -**		*Go to GHG Analysis sheet*

Vancouver Island
8% IRR
40 year lifetime of project

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name					
Project location		Vancouver Island			
Renewable energy delivered	MWh	40,441	Net GHG reduction	t_{CO2}/yr	18,270
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 40 yrs	t_{CO2}	730,819

Financial Parameters

Avoided cost of energy	CAD/kWh	0.0873	Debt ratio	%	75.0%
RE production credit	CAD/kWh	0.010	Debt interest rate	%	7.0%
RE production credit duration	yr	10	Debt term	yr	15
RE credit escalation rate	%	0.0%			
GHG emission reduction credit	CAD/t_{CO2}	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	0.5%			
Inflation	%	2.5%			
Discount rate	%	10.0%			
Project life	yr	40			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	1.0%	CAD	279,000	O&M	CAD	850,470
Development	0.7%	CAD	174,000			
Engineering	0.9%	CAD	235,000	Debt payments - 15 yrs	CAD	2,191,128
Energy equipment	87.9%	CAD	23,400,000	**Annual Costs and Debt - Total**	**CAD**	**3,041,597**
Balance of plant	6.2%	CAD	1,645,000			
Miscellaneous	3.3%	CAD	875,804	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**CAD**	**26,608,804**	Energy savings/income	CAD	3,531,691
				Capacity savings/income	CAD	-
Incentives/Grants		CAD	-	RE production credit income - 10 yrs	CAD	404,408
				Annual Savings - Total	**CAD**	**3,936,099**
Periodic Costs (Credits)						
Repair		CAD	500,000	Schedule yr # 15,30		
Turbine Replacement		CAD	23,400,000	Schedule yr # 21		
		CAD	-			
End of project life - Credit		CAD	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	7.9%			
After-tax IRR and ROI	%	7.9%	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	8.6			
Year-to-positive cash flow	yr	7.6	Project equity	CAD	6,652,201
Net Present Value - NPV	CAD	(957,297)	Project debt	CAD	19,956,603
Annual Life Cycle Savings	CAD	(97,893)	Debt payments	CAD/yr	2,191,128
Benefit-Cost (B-C) ratio	-	0.86	Debt service coverage	-	1.40

Yearly Cash Flows

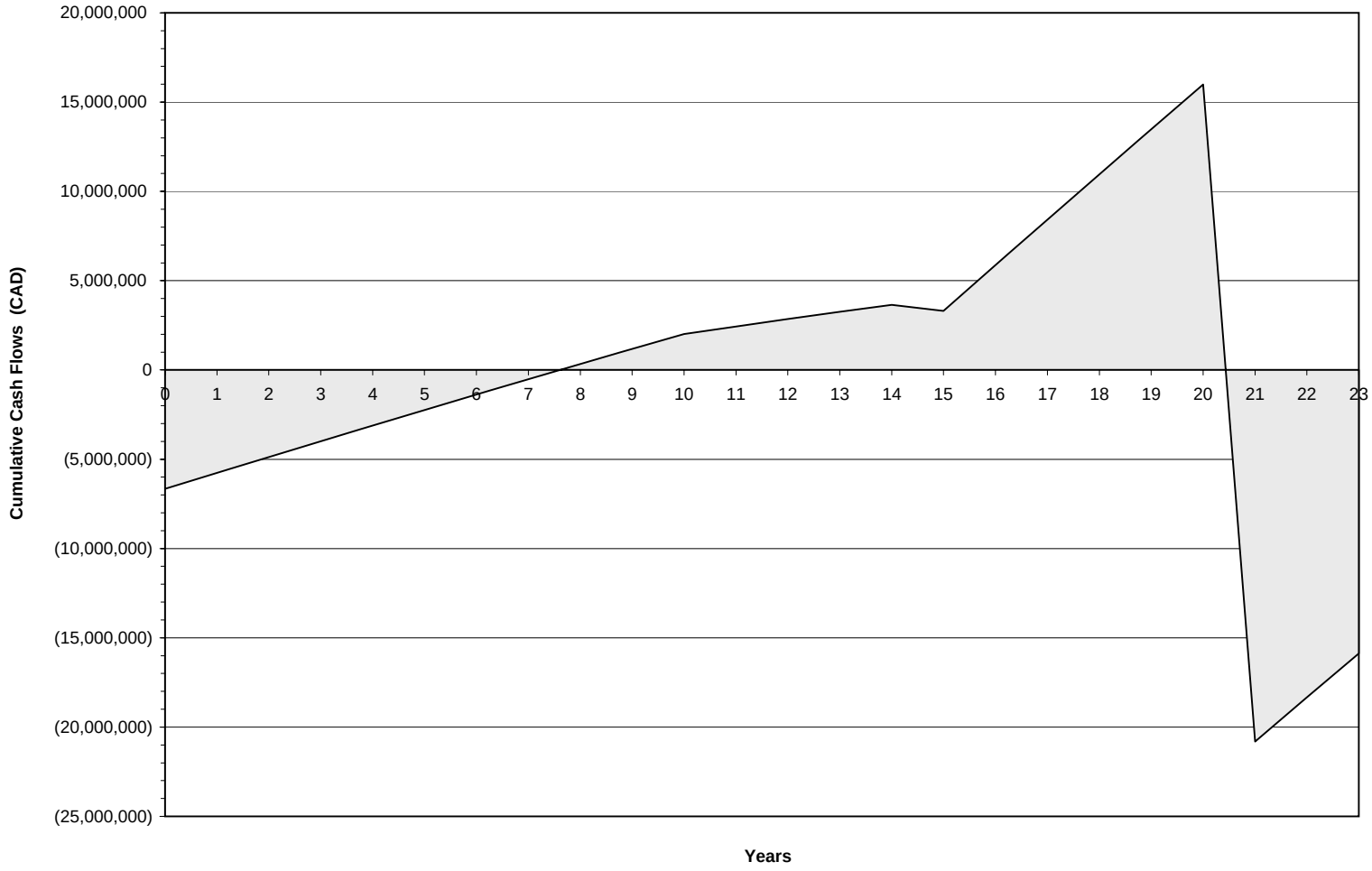
Year #	Pre-tax CAD	After-tax CAD	Cumulative CAD
0	(6,652,201)	(6,652,201)	(6,652,201)
1	890,898	890,898	(5,761,303)
2	886,851	886,851	(4,874,451)
3	882,349	882,349	(3,992,103)
4	877,377	877,377	(3,114,726)
5	871,922	871,922	(2,242,803)
6	865,971	865,971	(1,376,833)
7	859,509	859,509	(517,324)
8	852,521	852,521	335,197
9	844,993	844,993	1,180,190
10	836,909	836,909	2,017,099
11	423,846	423,846	2,440,945
12	414,603	414,603	2,855,548
13	404,756	404,756	3,260,305
14	394,288	394,288	3,654,593
15	(340,968)	(340,968)	3,313,625
16	2,562,546	2,562,546	5,876,171
17	2,550,108	2,550,108	8,426,279
18	2,536,977	2,536,977	10,963,255
19	2,523,133	2,523,133	13,486,388
20	2,508,556	2,508,556	15,994,945
21	(36,808,988)	(36,808,988)	(20,814,043)
22	2,477,125	2,477,125	(18,336,919)
23	2,460,228	2,460,228	(15,876,691)
24	2,442,514	2,442,514	(13,434,177)
25	2,423,961	2,423,961	(11,010,216)
26	2,404,546	2,404,546	(8,605,670)
27	2,384,246	2,384,246	(6,221,424)
28	2,363,037	2,363,037	(3,858,387)
29	2,340,893	2,340,893	(1,517,495)
30	1,269,005	1,269,005	(248,489)
31	2,293,699	2,293,699	2,045,210
32	2,268,598	2,268,598	4,313,808
33	2,242,456	2,242,456	6,556,264
34	2,215,247	2,215,247	8,771,511
35	2,186,941	2,186,941	10,958,451
36	2,157,509	2,157,509	13,115,960
37	2,126,920	2,126,920	15,242,880
38	2,095,145	2,095,145	17,338,025
39	2,062,150	2,062,150	19,400,174
40	2,027,903	2,027,903	21,428,077

Vancouver Island
8% IRR
40 year lifetime of project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
Vancouver Island

Renewable energy delivered (MWh/yr): 40,441 **Total Initial Costs: CAD 26,608,804** **Net average GHG reduction (t_{CO2}/yr): 18,270**



IRR and ROI: 7.9% **Year-to-positive cash flow: 7.6 yr** **Net Present Value: CAD -957,297**

Vancouver Island
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	Yes	Sensitivity range	10%
Project name		Threshold	0.0 %
Project location	Vancouver Island		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
36,397	-10%	-1.1%	0.7%	2.8%	5.3%	8.4%
38,419	-5%	0.2%	2.4%	5.0%	8.4%	12.1%
40,441	0%	1.7%	4.4%	**7.9%**	11.9%	15.8%
42,463	5%	3.5%	7.0%	11.3%	15.6%	19.3%
44,485	10%	5.8%	10.3%	14.9%	19.0%	22.6%

Initial costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
23,947,923	-10%	3.8%	8.6%	14.1%	18.7%	22.6%
25,278,364	-5%	2.6%	6.0%	10.5%	15.1%	19.1%
26,608,804	0%	1.7%	4.4%	**7.9%**	11.9%	15.8%
27,939,244	5%	1.0%	3.3%	6.1%	9.4%	13.0%
29,269,684	10%	0.4%	2.5%	4.8%	7.5%	10.6%

Annual costs (CAD)		Avoided cost of energy (CAD/kWh)				
		0.0786	0.0830	**0.0873**	0.0917	0.0961
		-10%	-5%	0%	5%	10%
765,423	-10%	3.5%	6.6%	10.3%	14.2%	17.8%
807,946	-5%	2.6%	5.5%	9.1%	13.1%	16.9%
850,470	0%	1.7%	4.4%	**7.9%**	11.9%	15.8%
892,993	5%	0.8%	3.4%	6.7%	10.7%	14.8%
935,516	10%	0.0%	2.4%	5.5%	9.5%	13.6%

Debt interest rate (%)		Debt ratio (%)				
		67.5%	71.3%	**75.0%**	78.8%	82.5%
		-10%	-5%	0%	5%	10%
6.3%	-10%	8.8%	9.1%	9.5%	9.9%	10.6%
6.7%	-5%	8.3%	8.4%	8.6%	8.9%	9.3%
7.0%	0%	7.7%	7.8%	**7.9%**	8.0%	8.1%
7.4%	5%	7.2%	7.2%	7.2%	7.2%	7.2%
7.7%	10%	6.8%	6.7%	6.6%	6.5%	6.4%

Debt interest rate (%)		Debt term (yr)				
		13.5	14.3	**15.0**	15.8	16.5
		-10%	-5%	0%	5%	10%
6.3%	-10%	9.6%	9.5%	9.5%	10.6%	10.6%
6.7%	-5%	9.0%	8.8%	8.6%	9.7%	9.6%
7.0%	0%	8.4%	8.1%	**7.9%**	8.8%	8.6%
7.4%	5%	7.8%	7.5%	7.2%	8.1%	7.8%
7.7%	10%	7.3%	6.9%	6.6%	7.3%	7.0%

RE delivered (MWh)		RE production credit (CAD/kWh)				
		0.009	0.010	**0.010**	0.011	0.011
		-10%	-5%	0%	5%	10%
36,397	-10%	2.7%	2.7%	2.8%	2.9%	3.0%
38,419	-5%	4.8%	4.9%	5.0%	5.2%	5.3%
40,441	0%	7.4%	7.7%	**7.9%**	8.1%	8.4%
42,463	5%	10.7%	11.0%	11.3%	11.7%	12.0%
44,485	10%	14.2%	14.5%	14.9%	15.2%	15.6%

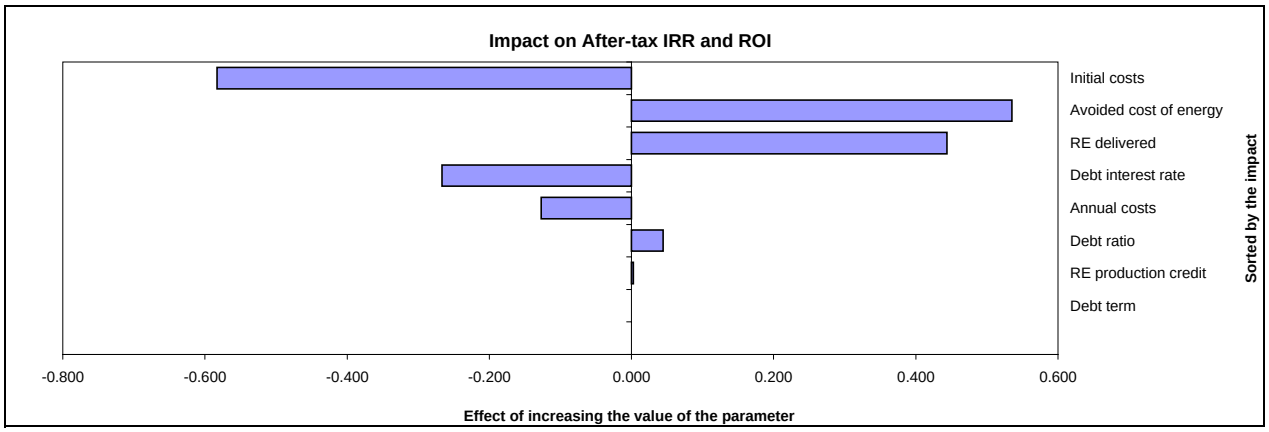
Vancouver Island
8% IRR
40 year lifetime of project

RETScreen® Sensitivity and Risk Analysis - Wind Energy Project

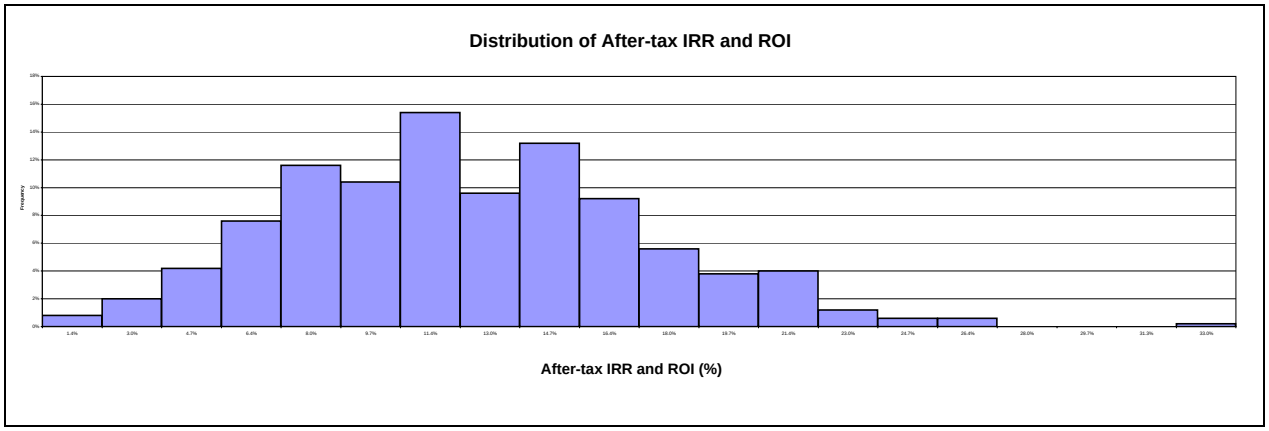
Risk Analysis for After-tax IRR and ROI

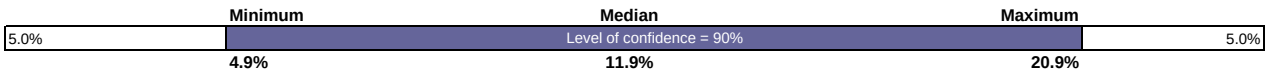
Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Avoided cost of energy	CAD/kWh	0.0873	15%	0.0742	0.1004
RE delivered	MWh	40,441	15%	34,375	46,507
Initial costs	CAD	26,608,804	20%	21,287,043	31,930,565
Annual costs	CAD	850,470	15%	722,899	978,040
Debt ratio	%	75.0%	5%	71.3%	78.8%
Debt interest rate	%	7.0%	30%	4.9%	9.1%
Debt term	yr	15	0%	15	15
RE production credit	CAD/kWh	0.010	10%	0.009	0.011

Click here to Calculate Risk Analysis



Median	%	11.9%
Level of risk	%	10%
Minimum within level of confidence	%	4.9%
Maximum within level of confidence	%	20.9%





Vancouver Island
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